OSNOVE STANDARDIZACIJE

Mag. Alojz Hudobivnik
alojz.hudobivnik@gmail.com
AH.TS s.p.

O predavatelju:

- Mag. računalništva (1989, FE Ljubljana)
- Delal v ISKRA DELTA, ISKRATEL, NICELABEL, COSYLAB, zadnjih 5 let kot AH.TS s.p.
- Predavatelj višje šole (SCPET, SCKR, CPU)
- Zaradi delovnih potreb se vključi v mednarodno standardizacijo na področju telekomunikacij (1994 ITU, 1996 ETSI, 2015 CENELEC)
- Zastopa Slovenijo na delovnih sestankih ITU in ETSI ter organizira sestanke v Sloveniji (ETSI TISPAN(2005), FG IPTV(2007), FG FN (2010))
- Pomembnejše funkcije:
  - 2009-2012 je bil Ass.Raporteur ITU-T SG13 Q.21/13 (Future Networks).
  - 2013-2016 je bil Vice-chairman ITU-T SG13 WP3 (SDN and FN) in Raporteur Q15/13
  - 2019-2020 je Vice-chairman ITU-T SG13 WP1 (IMT-2020 Networks & Systems)
  - 2015-2023 je predsednik Strokovnega sveta EIT pri SIST, prej član (2011-15) , vodja SIST TC SPN (2003-)
  - Vodja delavnic VITEL, podpredsednik društva SIKOM (2005-2019), predsednik društva SOMTA(2020-22), prej tajnik (2014-)
- Udeleženec oz. predavatelj na:
  - World Telecom Forum (2012, Dubai), (2014, Qatar)
  - MAS 2014 (Moskva)
  - Future Internet Forum (FP7) 2011, 2012
  - WTSA-2012
  - ITU Telecom Forum (1991,1995, 1999, 2003, 2006)
- IEEE Senior Member (IEEE SDN Initiative - chairman of Publicity Commitee 2014-2017)

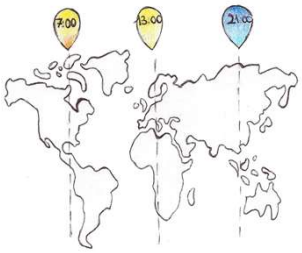
2020 - Copyright mag. Alojz Hudobivnik

Vsebina tečaja

- **1. DEL:**
  - Pomen standardizacije
  - Standardizacijske organizacije in način delovanja
    - ITU
    - IEEE
    - ISO
    - IEC
    - IETF
    - ETSI
  - Kako delujemo v SLOVENIJI
    - SIST
    - Sintesio
- **2. DEL:**
  - Aktualne teme na področju IKT standardizacije
    - „Future networks“ standardizacija
    - Standardizacije 5G in NET2030

Zakaj sploh rabimo standarde

Npr.: Kaj če ?



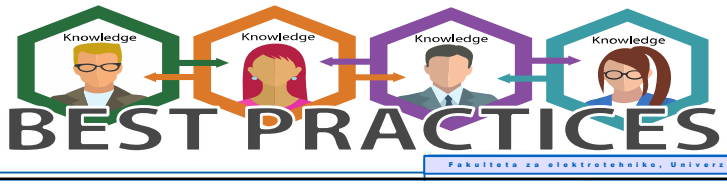
… ne bi imeli skupnega svetovnega načina za merjenje časa in skupnih postopkov za npr. upravljanje zračnega prometa

... bi vsak računalnik imel svojo tipkovnico

vsak pametni telefon in osebni računalnik imel svoj specifičen sklop priključkov in polnilnikov (čeprav ga nekateri imajo...)

Zakaj so standardi pomembni?

- **standardi podpirajo konkurenčnost podjetij na svetovnem trgu s tem, da:**
  - **razširjajo nova znanja in inovacije,**
  - **zagotavljajo stabilnost,**
  - **zagotavljajo interoperabilnost med novimi in starimi izdelki, storitvami in procesi,**
  - **omogočajo lažji dostop na trg,**



Kaj so standardi?

Zakaj potrebujemo standarde v IKT:

Omogočajo medsebojno komunikacijo programom in strojni opremi (slike, tekst, telefonski pogovori)

Različne možnosti uporabe

- obe strani lahko uporabljata isti standard (dogovor), kako interpretirati niz bitov
- ena od strani mora privzeti standard druge
- uporaba "prevajalca" med obema stranema

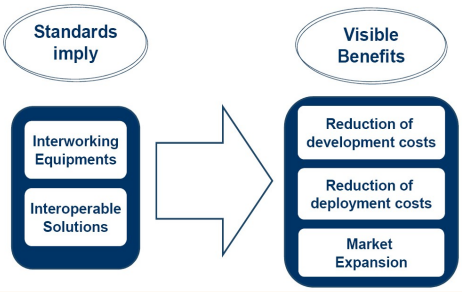
Neuporaba lahko onemogoči komunikacijo, ali pa vodi k napačni interpretaciji informacij

Standardi so dokumentirani dogovori, ki vsebujejo tehnične specifikacije ali druge natačno določene kriterije, ki se konsistentno uporabljajo kot pravila, smernice ali definicije lastnosti, da bi materiali, izdelki ali storitve ustrezale svojim namenom.

ISO, www.iso.ch/infoe/intro.html

Nastanek standarda

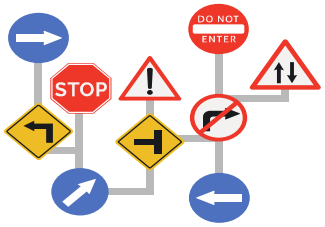
- Standardi predstavljajo dogovor (konsenz) med deležniki v korist uporabnikov
- Zakaj standardi izboljšajo produkt?
  - poenotijo terminologijo in notacijo
  - predlagajo določene procese
  - predlagajo kriterije za merjenje in evaluacijo
  - določajo "najboljšo prakso"
  - zmanjšajo število nesporazumov s stranko
- Kakšne so koristi?



Country	Publisher	Time frame	Growth rate of GDP	Contribution of standards
France	AFNOR (2009)	1950 – 2007	5.4 %	0.8 %
United Kingdom	DTI (2005)	1948 – 2002	2.5 %	0.3 %
Canada	Standards Council of Canada (2007)	1981 – 2004	2.7 %	0.2 %
Australia	Standards Australia (2006)	1962 – 2003	3.6%	0.8%
Source: Blind et al. (2011)				

Uporaba "standarda"

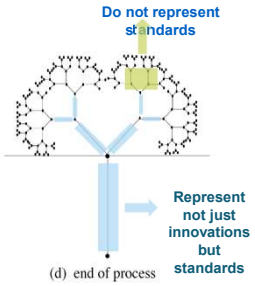
- "standard" je nepravilen izraz, morali bi uporabljati PRIPOROČILO
- Priporočilo postane obvezno, ko to določi država z zakonom ali EC z direktivo
- Rešitev priporočila je lahko zaščitena z IPR-om katerega od predlagateljev. To mora biti navedeno. Praviloma lastnik poda izjavo, da pravice IPR lahko vsak odkupi za normalno pošteno ceno.



Nastajanja standardov

DVA tipa standardov:

- Formalni standardi razviti uradno v industrijskih ali vladnih organih
- Defacto standardi se pojavljajo na trgu in imajo podporo enega ali več proizvajalcev, vendar nimajo uradnega položaja.



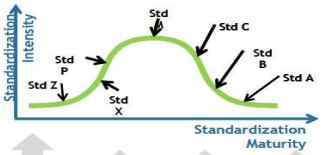
Formalni standardizacijski proces ima 3 faze:

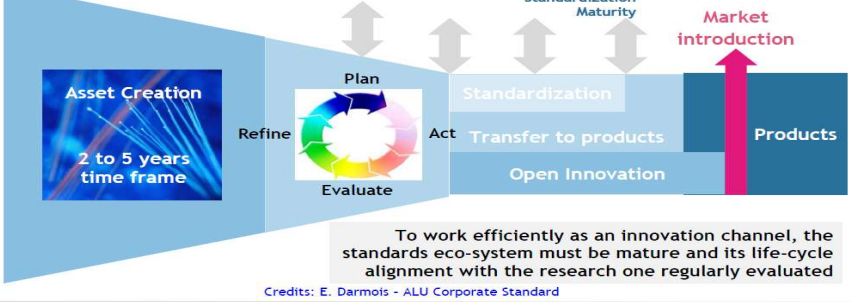
1. Specification stage: razvoj nomenklature in identifikacija problemov ki jih je potrebno rešiti.
2. Identification of choices stage: udeleženci, ki delajo na standardu, opredelijo različne rešitve in izberejo optimalno rešitev izmed alternativ.
3. Acceptance, the most difficult stage: opredelitev rešitve in pridobitev priznanih industrijskih voditeljev, da se dogovorijo o enotni univerzalni rešitvi.

Kdaj nastajajo standardi?

Closing the Standardization Gap
Aligning Research and Standardization Life-cycles

Standardization may be a pre-condition for research results to be turned into products: good partners, speed and time-to-market required !





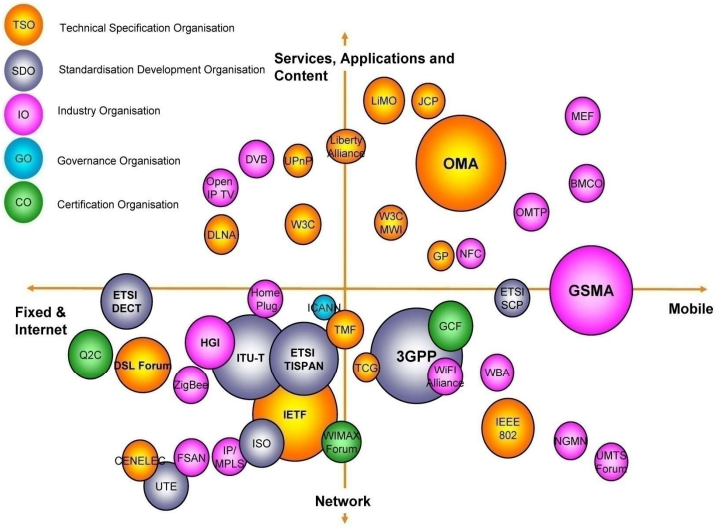
To work efficiently as an innovation channel, the standards eco-system must be mature and its life-cycle alignment with the research one regularly evaluated

Credits: E. Darmois - ALU Corporate Standard

4 | EC D1 Concertation Meeting | 10.02.11 - Brussels © Alcatel-Lucent 2011 Alcatel·Lucent

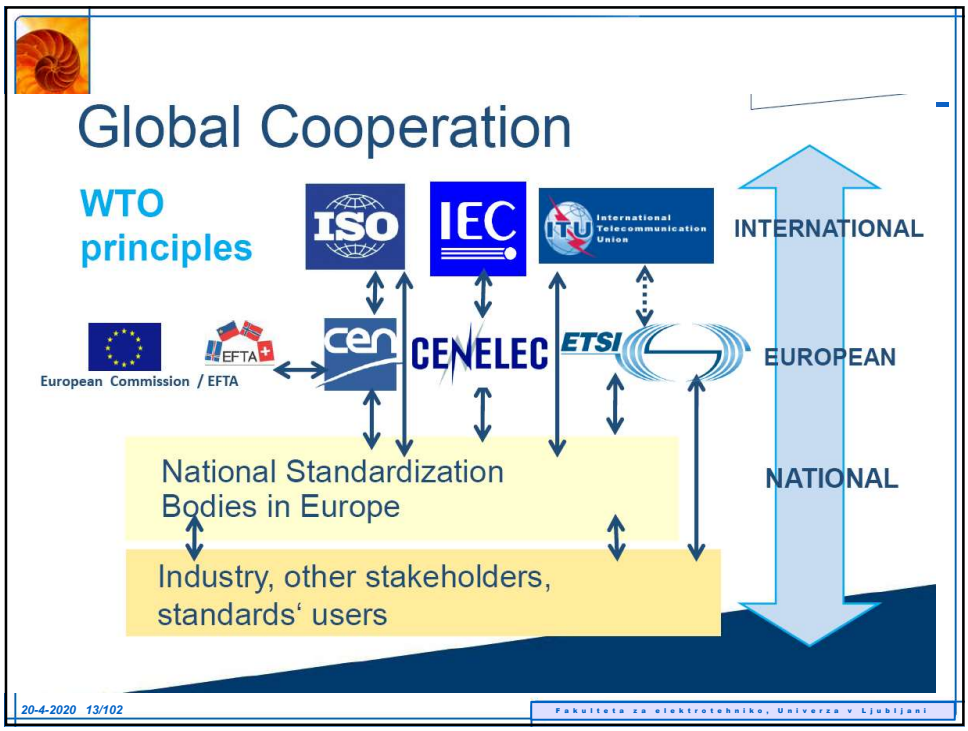
20-4-2020 10/102

Klasifikacija standardizacijskih organizacij



Standardizacijske organizacije

- **Mednarodne**
  - Mednarodna organizacija za standardizacijo(ISO) http://www.iso.ch
  - Mednarodna elektrotehniška komisija (IEC) http://www.iec.ch
  - Mednarodna unija za telekomunikacije (ITU) http://www.itu.int
  - Internet Society / Internet Engineering Task Force http://www.isoc.org http://www.ietf.org
- **Evropske**
  - Evropski komite za standardizacijo (CEN) http://www.cen.eu
  - Evropski komite za standardizacijo v elektrotehniki (CENELEC) http://www.cenelec.org
  - Evropski telekomunikacijski inštitut za standarde (ETSI) http://portal.etsi.org
- **Slovenske**
  - Slovenski inštitut za standardizacijo (SIST) www.sist.si
- **Mednarodna strokovna združenja**
  - Institute of Electrical and Electronics Engineers http://www.ieee.org/
  - World Wide Web Consortium http://www.w3.org/
  - 3rd Generation Partnership Project http://www.3gpp.org


Global Cooperation
WTO principles
ISO
IEC
ITU International Telecommunication Union
INTERNATIONAL
European Commission / EFTA
EFTA
cen
CENELEC
ETSI
EUROPEAN
National Standardization Bodies in Europe
NATIONAL
Industry, other stakeholders, standards' users
20-4-2020 13/102
Fakulteta za elektrotehniko, Univerza v Ljubljani


Globalnost – regionalnost - sodelovanje
Interregional collaboration on selected standardization subjects between
ETSI World Class Standards
CCSA (China)
ARIB
ARIB (Japan)
TTC (Japan)
isacc cccnt
ISACC (Canada)
TIA
TIA (USA)
TTA (Korea)
ATIS
ATIS (USA)
ITU (International)
acif
ACIF (Australia)
20-4-2020 14/102
Fakulteta za elektrotehniko, Univerza v Ljubljani

ITU (International Telecommunication Union)

- ITU je specializirana agencija OZN s sedežem v Ženevi (CH)
- Ustanovljena 17.maja 1865
- Organizacije OZN, kjer vlade in privatna podjetja na meddržavni ravni koordinirajo svoja omrežja in storitve (193 držav, 700 organizacij)
- Članice (države, operaterji, proizvajalci opreme ...)
- Zgodovina ...

1837 Invention of the first electric telegraph

1844 Samuel Morse sent his first public message over a telegraph line between Washington and Baltimore

1865-1934: International Telegraph Union

1934-: International Telecommunication Union

- Do 1993: CCITT, CCIR
- Po 1993: ITU-T, ITU-R, ITU-D

- Uradni jeziki (Eng, Fra, Špa, Rus, Arab, Kit)

20-4-2020 15/102 Fakulteta za elektrotehniko, Univerza v Ljubljani

ITU (International Telecommunication Union)

- Generalni sekretar ITU: Houlin Zhao, Kitajska

Nam. generalnega sekretarja
Malcolm Johnson, UK

2018-22

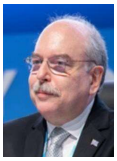
www.itu.int

20-4-2020 16/102 Fakulteta za elektrotehniko, Univerza v Ljubljani

3 ITU sektorji delovanja

- **ITU-R: Manage radio spectrum and satellite orbits**

Mario Maniewicz – Uruguay



- **ITU-T: Develops ICT and telecommunication standards**

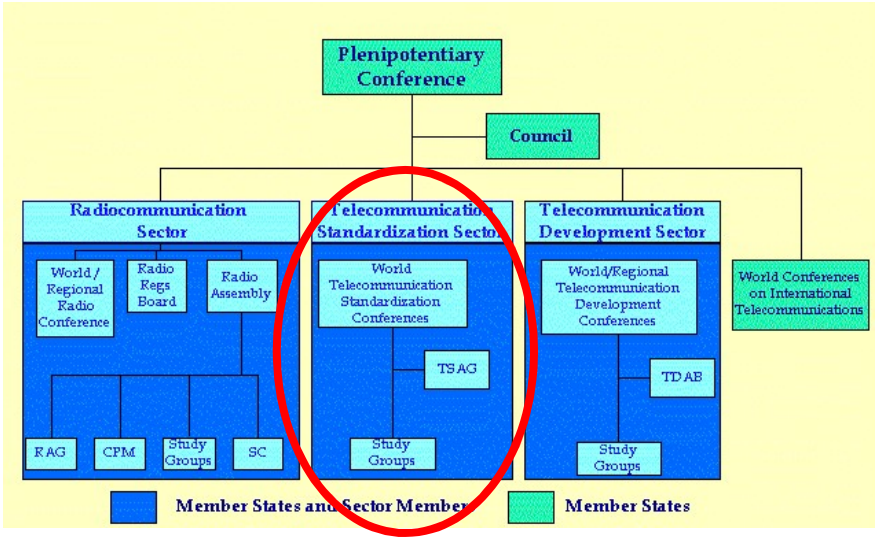
ChaeSub Lee, Južna Koreja

- **ITU-D: Promotes ICT development**

Doreen Bogdan-Martin – US

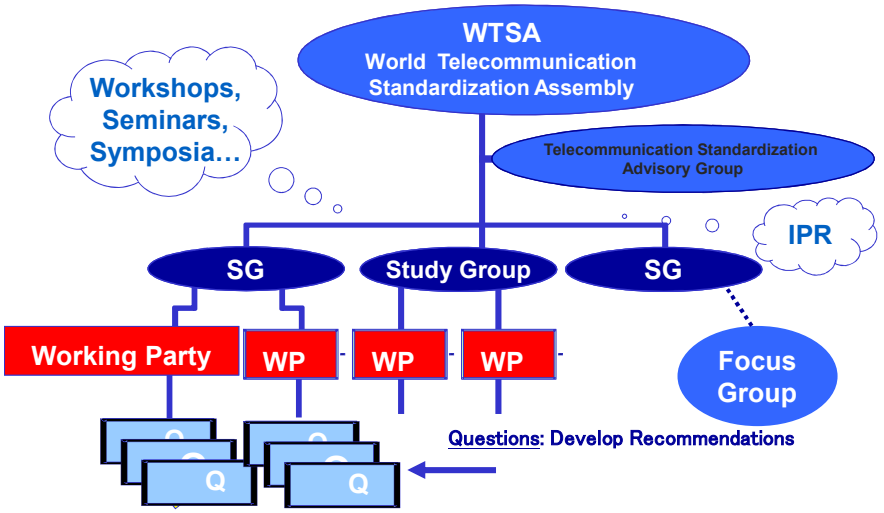
20-4-2020 17/102 Fakulteta za elektrotehniko, Univerza v Ljubljani

ORGANIZACIJA ITU



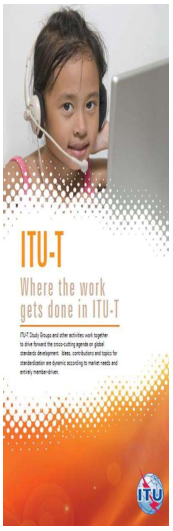
20-4-2020 18/102 Fakulteta za elektrotehniko, Univerza v Ljubljani

ITU-T organizacijska struktura



ŠTUDIJSKE SKUPINE (ITU-T) 2017-2020

- Study Group 2: **Operational aspects**
- Study Group 3: **Economic and policy issues**
- Study Group 5: **Environment and climate change**
- Study Group 9: **Broadband cable and TV**
- Study Group 11: **Protocols and test specifications**
- Study Group 12: **Performance, QoS and QoE**
- Study Group 13: **Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructures**
- Study Group 15: **Transport, Access and Home**
- Study Group 16: **Multimedia**
- Study Group 17: **Security**
- Study Group 20: **Internet of Things (IoT) and smart cities and communities (SC&C)**



SG13 – t.i. arhitekturna skupina

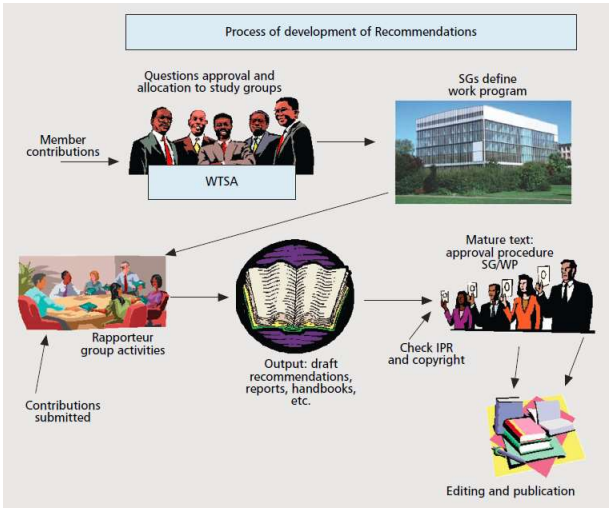
SG13 - Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructures

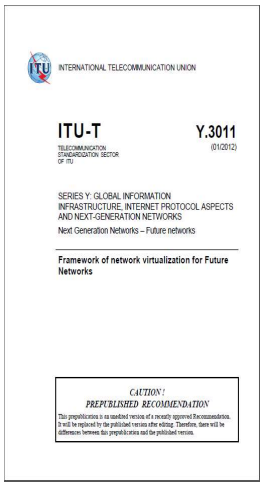
- **Vodilna SG za področja:**
  - future networks
  - mobility management and NGN
  - cloud computing
  - Software Defined Networking
- **Tipična udeležba zasedanja:**
  - 200 delegatov iz 37 držav
  - Približno 230 contributions

Study Group 13 – Questions (2019)

6/13	Quality of service (QoS) aspects including IMT-2020 networks
20/13	IMT-2020: Network requirements and functional architecture
21/13	Network softwarization including software-defined networking, network slicing and orchestration
22/13	Upcoming network technologies for IMT-2020 and Future Networks
23/13	Fixed-Mobile Convergence including IMT-2020
7/13	Big data driven networking (bDDN) and Deep packet inspection (DPI)
17/13	Requirements, ecosystem, and general capabilities for cloud computing and big data
18/13	Functional architecture for cloud computing and big data
19/13	End-to-end cloud computing management, cloud security and big data governance
1/13	Innovative services scenarios, deployment models and migration issues based on Future Networks
2/13	NGN evolution with innovative technologies including SDN and NFV
5/13	Applying networks of future and innovation in developing countries
16/13	Knowledge-centric trustworthy networking and services

INTERNA ORGANIZACIJA DELA V STANDARDIZACIJSKI ORGANIZACIJI




INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Y.3011

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

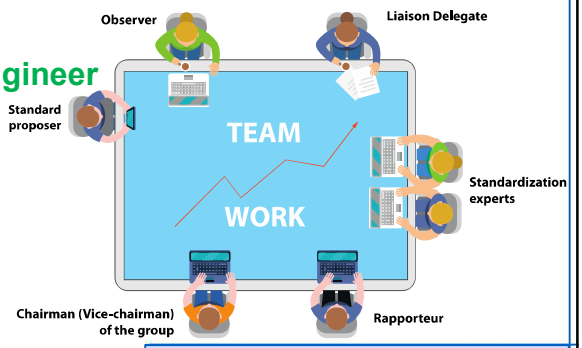
Next Generation Networks – Future networks

Framework of network virtualization for Future Networks

CAUTION!
PREPUBLISHED RECOMMENDATION

Kdo je kdo v študijski skupini

- Study group chairmen (and vice-chairmen)
- Working party chairmen (and vice-chairmen)
- Rapporteurs
- Liaison rapporteurs
- Editors
- Delegates
- Counselor/advisor/engineer
- Assistant



Oblika sestanka v ITU-T

- **Opening and closing plenary sessions take place at SG, WP, and Question levels.**

SG opening

WP opening

Question opening

Q

Q

Question closing

WP closing

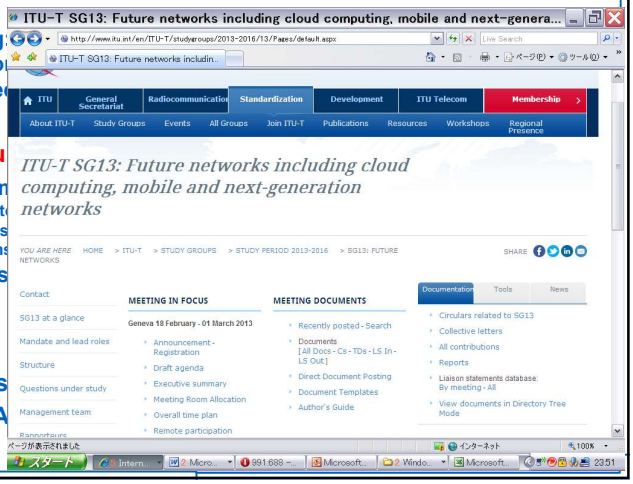
SG closing

Editing

ONE SG MEETING IN ONE OR TWO WEEKS

Delovne metode

- **Questions (projects)**
- **Acting on a particular standardization work programm (19 active within SG 13)**
- **Approved at the WTSA or by the Study Group**
- **Contributions driven (normal contributions, delayed contributions, temporary documents)**
  - **face-to-face meeting**
  - **debate, determinatio**
  - **SG/WP meetings: de**
- **Decision = consensus, u**
  - **Recommendations (An**
    draft Recommendations, det
    approved Recommendations
    published Recommendations
  - **Implementor's Guides**
- **Meeting reports**
- **Electronic submissions**
- **Paperless meeting – LA**



Slovarček

- RECOMMENDATION (priporočilo)
- OPERATIONAL BULLETIN (sporočila)
- REPORT (poročilo)
- CONTRIBUTION (prispevek)
- DELAYED CONTRIBUTION (zakasneli prispevki)
- TEMPORARY DOCUMENT (začasni dokument)
- Liaison Statements
- Circular (okrožnica)
- Collective letter (skupinsko pismo)

www.itu.int

Dokumentacija zasedanj – javni / interni

Circulars

Information of general interest

- Annual ITU-T meetings schedule
- Announcement on Workshops
- Announcement of Approval and deletion of Recommendations and Questions
- Questionnaire

Collective letters

Invitation to a specific SG/WP meeting with agenda, registration forms, etc.

AAP Announcements

Information on draft Recommendations under the AAP process *(electronic version only)*

- Reports

Official records of SG or WP meetings. To be available shortly after the closure of the meetings

Any ITU-T member may submit* contributions preferably electronically using the Templates!

Contributions

"Normal" or "Delayed" COM 13-D documents, submitted at least 12 *days* before the meeting

Temporary Documents

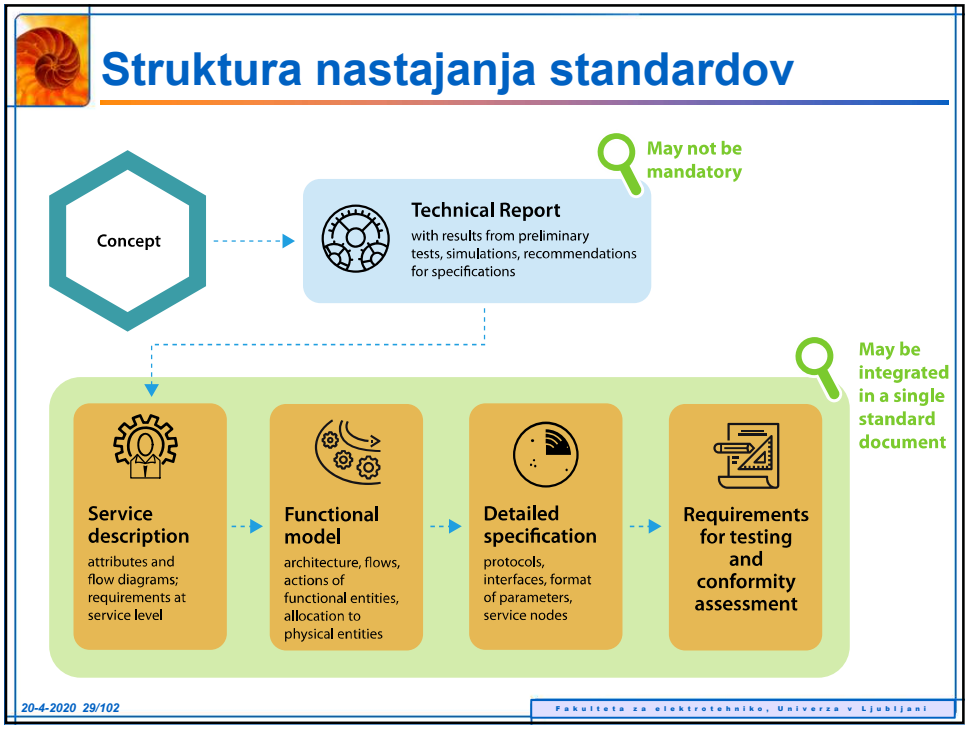
Submitted by a meeting'official' (a member of the SG Management Team, Rapporteur, Editor, etc.) or TSB

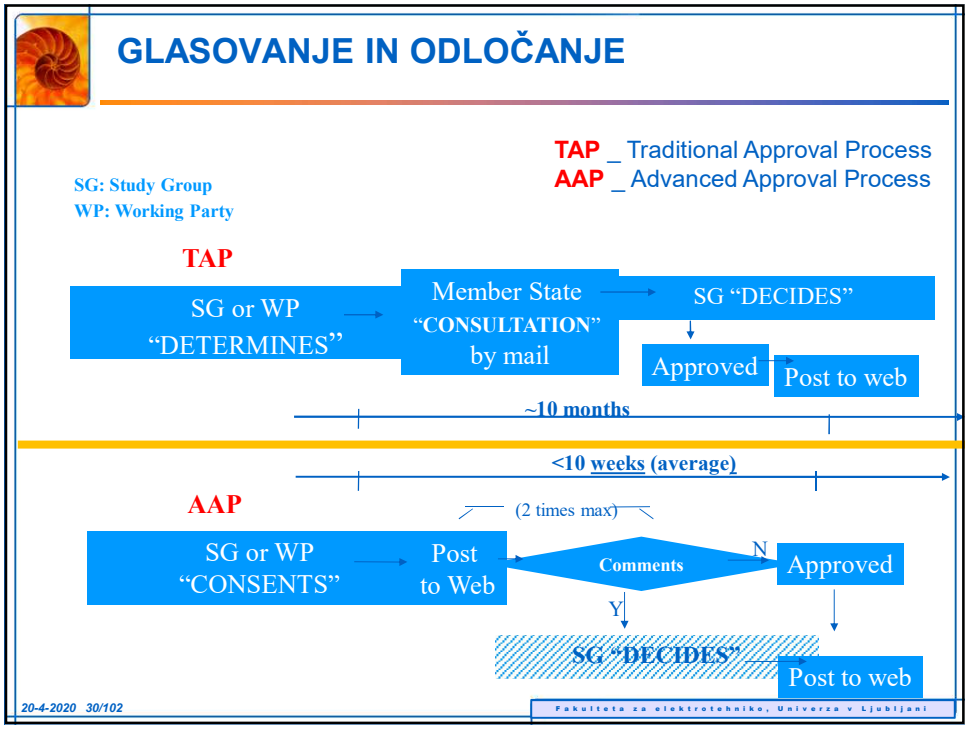
Include for example:

- Reports of interim Rapporteur meetings or other activities (Workshop, forum, etc.)
- Latest draft texts for Recommendations
- Inputs from other SGs known as "liaison statements"
- Inputs from other Standards Development Organizations (SDOs), forums and consortia, also known as "liaison statements"
- Reports and other output documents generated during the meeting on Questions or WP or SG plenaries

Working Documents

Distributed during meetings on Questions only to the participants. No official record


Struktura nastajanja standardov
May not be mandatory
Concept
Technical Report
with results from preliminary tests, simulations, recommendations for specifications
May be integrated in a single standard document
Service description
attributes and flow diagrams; requirements at service level
Functional model
architecture, flows, actions of functional entities, allocation to physical entities
Detailed specification
protocols, interfaces, format of parameters, service nodes
Requirements for testing and conformity assessment
20-4-2020 29/102
Fakulteta za elektrotehniko, Univerza v Ljubljani


GLASOVANJE IN ODLOČANJE
TAP _ Traditional Approval Process
AAP _ Advanced Approval Process
SG: Study Group
WP: Working Party
TAP
SG or WP "DETERMINES"
Member State "CONSULTATION" by mail
SG "DECIDES"
Approved
Post to web
~10 months
<10 weeks (average)
AAP
(2 times max)
SG or WP "CONSENTS"
Post to Web
Comments
N
Approved
Y
SG "DECIDES"
Post to web
20-4-2020 30/102
Fakulteta za elektrotehniko, Univerza v Ljubljani

ITU-T Recommendations Series (PROST DOSTOP!)

serija	vsebina serije
A	Organization of the work of the ITU-T
B	Means of expression: definitions, symbols, classification
C	General telecommunication statistics
D	General tariff principles
E	Overall network operation, telephone service, service operation and human factors
F	Non-telephone telecommunication services
G	Transmission systems and media, digital systems and networks
H	Audiovisual and multimedia systems
I	Integrated services digital network
J	Transmission of television, sound programme and other multimedia signals
K	Protection against interference
L	Construction, installation and protection of cables and other elements of outside plant
M	Maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
N	Maintenance: international sound programme and television transmission circuits
O	Specifications of measuring equipment
P	Telephone transmission quality, telephone installations, local line networks
Q	Switching and signalling
R	Telegraph transmission
S	Telegraph services terminal equipment
T	Terminals for telematic services
U	Telegraph switching
V	Data communication over the telephone network
X	Data networks and open system communication
Y	Global information infrastructure
Z	Programming languages

Področja najaktivnejšega dela

- Machine Learning and AI
- Smart city
- Cybersecurity including identity management (IdM)
- The fully networked car
- Cloud computing and SmartGrid
- Big Data
- 5G
- Videocoding
- Broadband access
- Optical transport network (OTN)
- Fibre optics
- Quantum key distribution
- ICTs and climate change

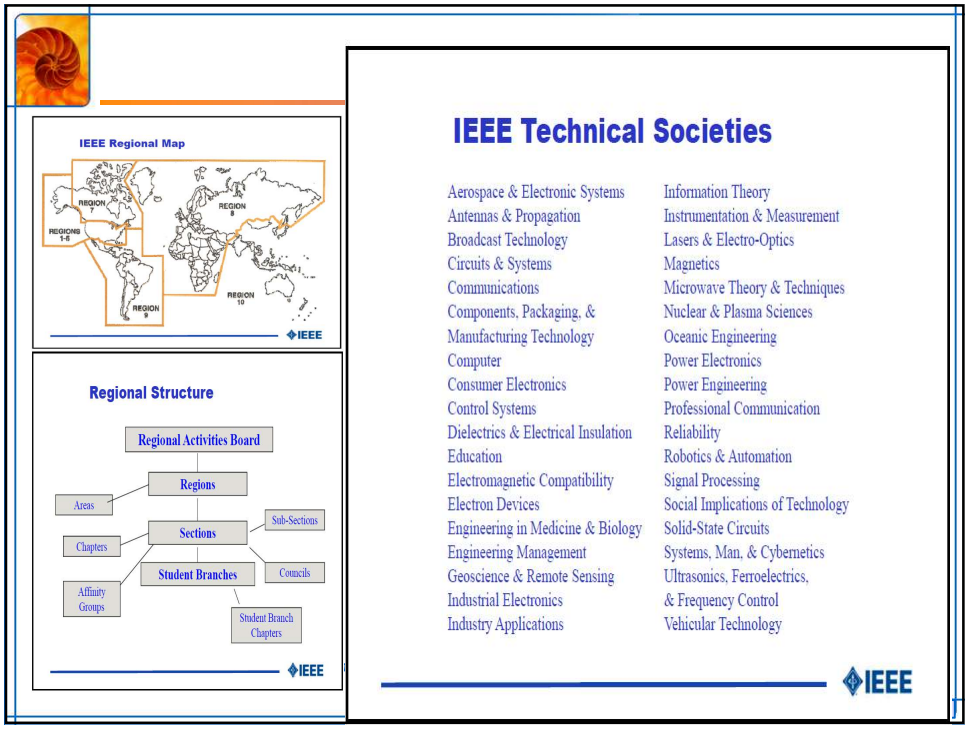
E-SODELOVANJE

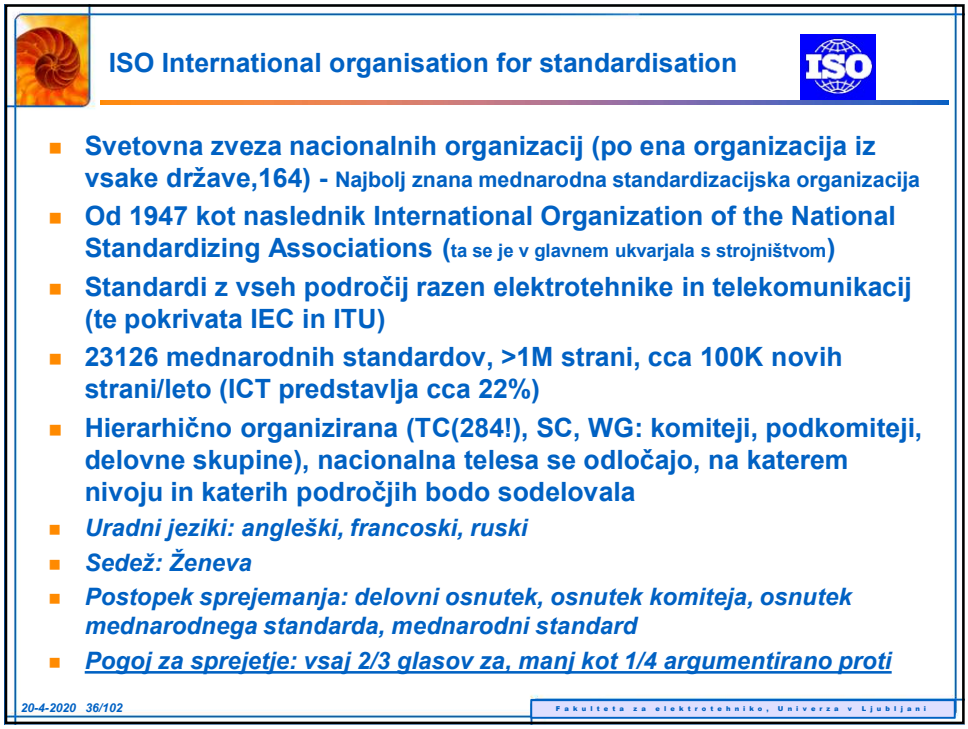
- Communication with TSB via Online Forms
- Alternative Approval Process (AAP)
- Guides, Tools and Templates
- Electronic Facilities for Meeting Participants
- ITU Website www.itu.int
  - Access to ITU-T Recommendations and other publications
    - Electronic Bookshop
    - Online free access!!!
  - Calendar of Events
  - Study Groups Pages
  - ITU-T Meeting Documents
  - Various Numbering Resources
  - Databases for the Membership

20-4-2020 33/102

Institute of Electrical and Electronics Engineers (IEEE)

- Največja mednarodna strokovna skupina, sodeluje pri razvoju standardov za računalništvo, komunikacije, elektrotehniko in elektroniko.
  Cilj: posodablja teorijo, ustvarjalnost in kakovost izdelkov na področjih elektrotehnike, elektronike in radia.
- 30% svetovne strokovne literature, konferenčni sponzor
- Sponzoriral je pomemben standard za lokalna omrežja imenovanih Project 802 (npr. 802.3, 802.4 in 802.5 standardi).


IEEE Regional Map
REGION 7
REGION 8
REGIONS 1-6
REGION 9
REGION 10
IEEE
Regional Structure
Regional Activities Board
Regions
Areas
Sub-Sections
Sections
Chapters
Student Branches
Councils
Affinity Groups
Student Branch Chapters
IEEE
IEEE Technical Societies
Aerospace & Electronic Systems
Antennas & Propagation
Broadcast Technology
Circuits & Systems
Communications
Components, Packaging, & Manufacturing Technology
Computer
Consumer Electronics
Control Systems
Dielectrics & Electrical Insulation
Education
Electromagnetic Compatibility
Electron Devices
Engineering in Medicine & Biology
Engineering Management
Geoscience & Remote Sensing
Industrial Electronics
Industry Applications
Information Theory
Instrumentation & Measurement
Lasers & Electro-Optics
Magnetics
Microwave Theory & Techniques
Nuclear & Plasma Sciences
Oceanic Engineering
Power Electronics
Power Engineering
Professional Communication
Reliability
Robotics & Automation
Signal Processing
Social Implications of Technology
Solid-State Circuits
Systems, Man, & Cybernetics
Ultrasonics, Ferroelectrics, & Frequency Control
Vehicular Technology
IEEE


ISO International organisation for standardisation
ISO
Svetovna zveza nacionalnih organizacij (po ena organizacija iz vsake države,164) - Najbolj znana mednarodna standardizacijska organizacija
Od 1947 kot naslednik International Organization of the National Standardizing Associations (ta se je v glavnem ukvarjala s strojništvom)
Standardi z vseh področij razen elektrotehnike in telekomunikacij (te pokrivata IEC in ITU)
23126 mednarodnih standardov, >1M strani, cca 100K novih strani/leto (ICT predstavlja cca 22%)
Hierarhično organizirana (TC(284!), SC, WG: komiteji, podkomiteji, delovne skupine), nacionalna telesa se odločajo, na katerem nivoju in katerih področjih bodo sodelovala
Uradni jeziki: angleški, francoski, ruski
Sedež: Ženeva
Postopek sprejemanja: delovni osnutek, osnutek komiteja, osnutek mednarodnega standarda, mednarodni standard
Pogoj za sprejetje: vsaj 2/3 glasov za, manj kot 1/4 argumentirano proti
20-4-2020 36/102
Fakulteta za elektrotehniko, Univerza v Ljubljani

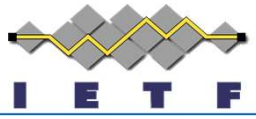
IEC

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

- Ustanovljen 1906, neprofitna, nevladna organizacija, sedež Ženeva (CH)
- članice iz 62 +26 držav (nacionalni komiteji, različni tipi članstva)
- "podpora mednarodnemu sodelovanju pri standardizaciji in ugotavljanju usklajenosti na področju elektrotehnike in elektronike"
- delo poteka v tehničnih odborih (TC), (108), odbor lahko ustanavlja pododbore (SC, cca 100), 7000 standardov +3000 dok.
- IEC lahko koordinira svoje delovanje z Evropskim komitejem za standardizacijo v elektrotehniki (CENELEC). To vodi k močnim standardom, saj so članice CENELEC tovrstne standarde obvezne sprejeti na nacionalnih ravneh.

Internet Engineering Task Force IETF

- Ustanovljen 1986
- Pripravlja standarde s področja interneta (RFC-)
- Sodeluje z drugimi standardizacijskimi organizacijami
- 2-3 konference na leto, 2000-3000 udeležencev
  - http://www.ietf.org
  - Consortium of individuals from
    - Research,
    - Education,
    - Network operators, and
    - Internet vendors



Fakulteta za elektrotehniko, Univerza v Ljubljani

IETF delovne skupine

- Vsi IETF protokoli so bili razviti v ~100 delovnih skupinah v enem od 8 področij
- Odločitev skupine temelji na "grobem konsenzu in delujoči kodi"
- Konsenz mora biti dosežen na mailing listi in ne na fizičnem sestanku
  - Internet
  - Routing
  - Transport
  - Applications
  - Security
  - Network operations and management
  - User services
  - General

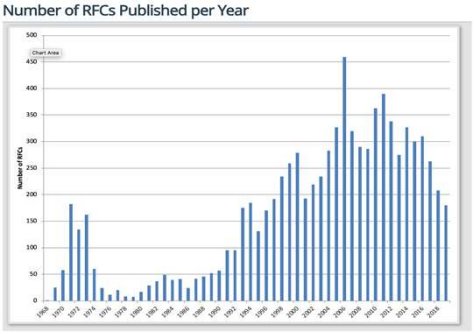
Primeri delovnih skupin
- avt Audio/Video Transport
- behave Behavior Engineering for Hindrance Avoidance
- dccp Datagram Congestion Control Protocol
- enum Telephone Number Mapping
- ieprep Internet Emergency Preparedness
- ippm IP Performance Metrics
- ips IP Storage
- iptel IP Telephony
- megaco Media Gateway Control
- midcom Middlebox Communication

Fakulteta za elektrotehniko, Univerza v Ljubljani

IETF - Internet Standardization Process

- All standards of the Internet are published as RFC (Request for Comments). But not all RFCs are Internet Standards
  - available: http://www.ietf.org
- A typical (but not only) way of standardization is:
  - Internet Drafts
  - RFC
  - Proposed Standard
  - Draft Standard (requires 2 working implementation)
  - Internet Standard (declared by IAB)

Number of RFCs Published per Year



Fakulteta za elektrotehniko, Univerza v Ljubljani

Kdo je „vodilni“ na področju …

Organization	Typical technical scope of activity
ITU	Interoperable telecom specifications incl. architecture, services, protocols, addressing / numbering plans
ISO	ICT architecture (OSI model) services, protocols incl. application protocols
IEC	Electrotechnical standards, incl. connectors, electrical safety and tests
ETSI	Interoperable telecom specifications incl. architecture, services
CEN	ICT architecture (OSI model) services, protocols incl. application protocols
CENELEC	Electrotechnical standards, incl. connectors, electrical safety and tests, ECM
IEEE	All LAN specifications: IEEE 802.xx, including cabled LANs, Token Ring and Bus, Wireless LANs WLAN, e.g. WiFi)
IETF	All internet related specifications including protocols, generic applications, addressing rules (IP, url)
ECMA	Media specifications, ICT specifications fed into ETSI, ISO/IEC, IEEE, etc.

ETSI

European Telecommunication Standards Institute (od 1988)
cca. 47 000 standardov (DVD 7,7GB+)

Lokacija: Sophia-Antipolis, Francija

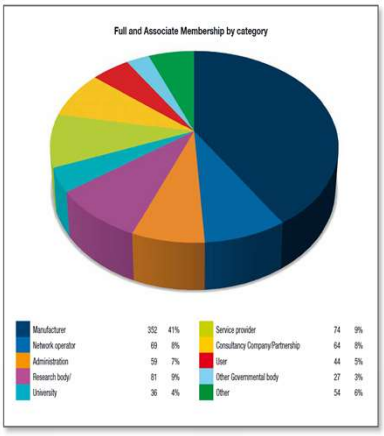
www.etsi.org

872 članov iz 64 držav

716 Full Members
from 42 CEPT countries

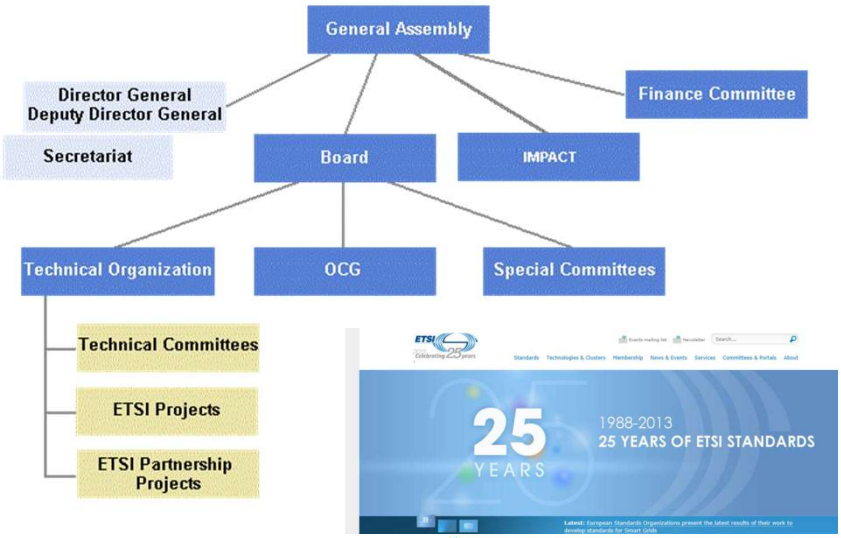
144 Associate Members
from 22 non-CEPT countries

14 Observers
from 14 countries



Slovenia: 3 members: SIST(4), SINTESIO(1), Iskratel(3)

ETSI organiziranost



ETSI's three primary roles

ESO
European Standards Organization

European Standards (EN)
Harmonised Standards (HS)

GSP
Global Standards Producer

Technical Specifications (TS)
Technical Reports (TR)
ETSI Standards (ES)
ETSI Guides (EG)

SPO
Service Providing Organization

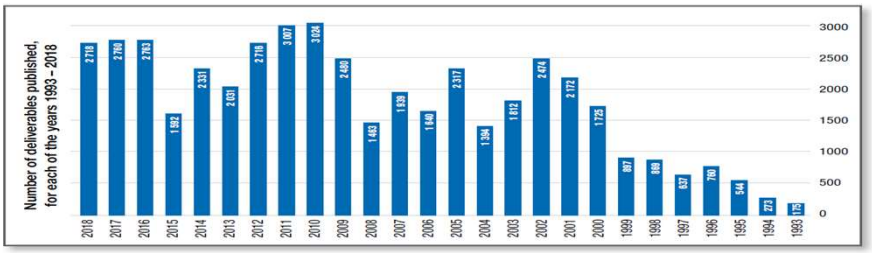
PLUGTESTS™ THE INTEROPERABILITY SERVICE — Interoperability service

FORAPOLIS The home of your Forum www.forapolis.com — Forum hosting and support services

Proizvedeni standardi

Standards Production

In 2018 we published 2 718 standards, specifications, reports and guides, bringing the total published since our establishment in 1988 to over 46 000.



Distribution by type of published document	In 2018	Total since 1988
Technical Specification (TS) [1]	2 307	36 448
Technical Report (TR) [2]	240	3 849
ETSI Standard (ES)	19	820
European Standard (telecommunications series) (EN) [3]	50	4 987
ETSI Guide (EG)	1	253
Special Report (SR)	3	103
Group Specification (GS)	65	238
Group Report (GR)	33	67
TOTAL	**2 718**	**46 765**

1) Includes GSM™ Technical Specification (GTS)
2) Includes old deliverable types: Technical Committee Reference Technical Report (TCR-TR), Technical Committee Technical Report (TC-TR) and ETSI Technical Report (ETR)
3) Includes amendments and old deliverable types: European Telecommunication Standard (ETS), Interim ETS (I-ETS) and Technical Basis for Regulation (TBR)

ETSI – Global Success

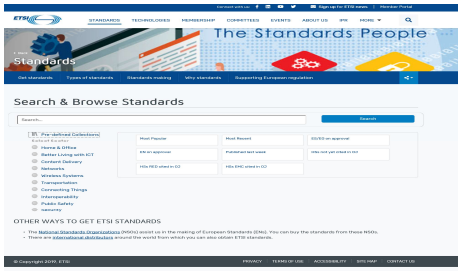
- NFV - Network Functions Virtualisation (new sincw 2012)
- DECT – Digital Enhanced Cordless Telecommunications
  - Originally Digital *European* Cordless Telecommunications
  - Over 200 million terminals in more than 110 countries
- DVB system specifications
  - Based on DVB Project proposals
  - Services available on every continent
- TETRA
  - Currently 788 contracts in 77 countries
- Radio microphones and cordless audio equipment
  - Global agreement on common standards
- Remember GSM ?
  - Developed (by ETSI) for Europe
  - Now a worldwide success story!
    - More than 6 billion users in over 200 countries
    - One million new users EVERY DAY!

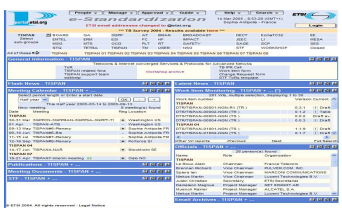
20-4-2020 47/102

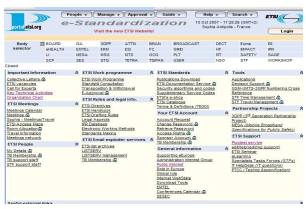
Fakulteta za elektrotehniko, Univerza v Ljubljani

ETSI WEB PORTAL!

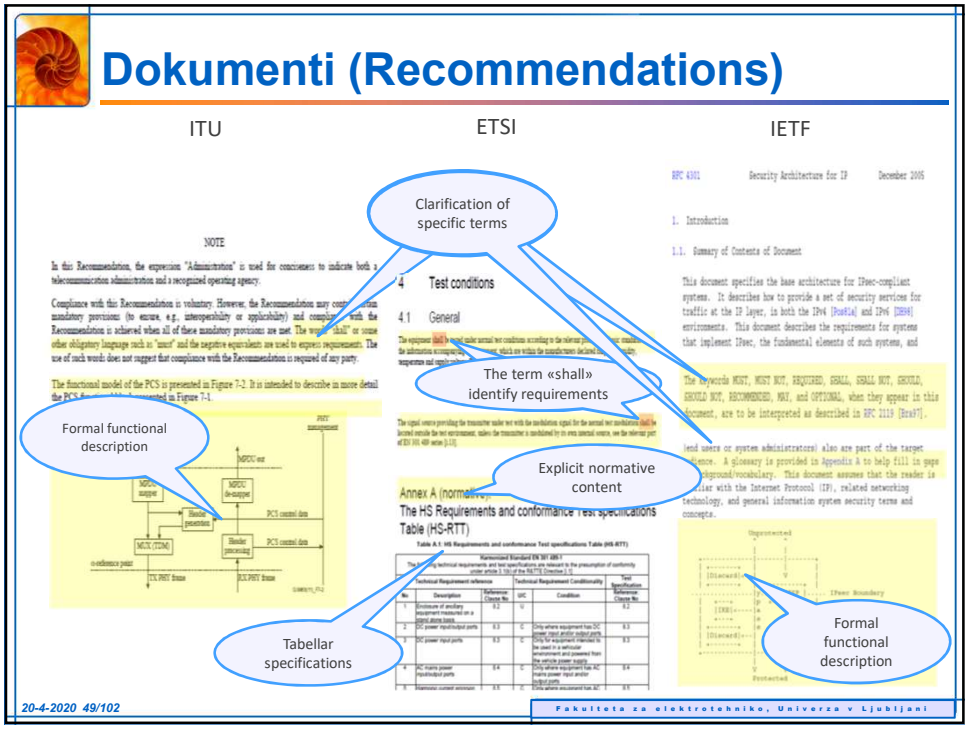
- ETSI website (http://www.etsi.org)
  - General public information
  - Free standards download
- ETSI portal (http://portal.etsi.org)
  - Easy access to data for each technical body
  - Working documents
  - ETSI applications and databases
- E-mail exploder lists
  - For all of ETSI's activities
- Work Programme

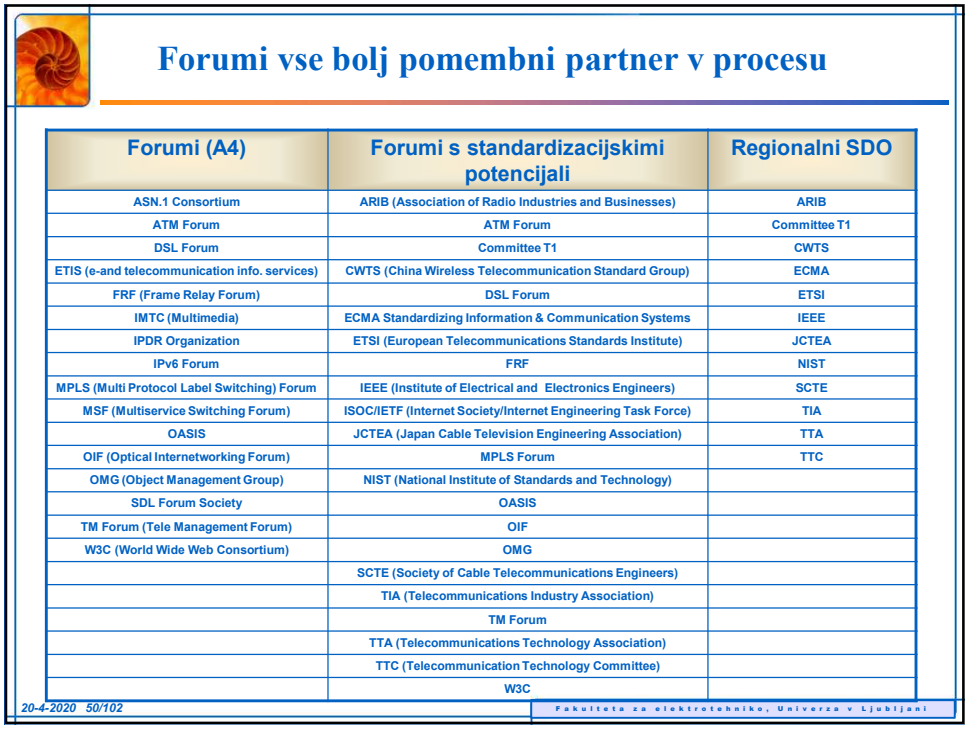






20-4-2020 48/102





Forumi (A4)	Forumi s standardizacijskimi potencijali	Regionalni SDO
ASN.1 Consortium	ARIB (Association of Radio Industries and Businesses)	ARIB
ATM Forum	ATM Forum	Committee T1
DSL Forum	Committee T1	CWTS
ETIS (e-and telecommunication info. services)	CWTS (China Wireless Telecommunication Standard Group)	ECMA
FRF (Frame Relay Forum)	DSL Forum	ETSI
IMTC (Multimedia)	ECMA Standardizing Information & Communication Systems	IEEE
IPDR Organization	ETSI (European Telecommunications Standards Institute)	JCTEA
IPv6 Forum	FRF	NIST
MPLS (Multi Protocol Label Switching) Forum	IEEE (Institute of Electrical and Electronics Engineers)	SCTE
MSF (Multiservice Switching Forum)	ISOC/IETF (Internet Society/Internet Engineering Task Force)	TIA
OASIS	JCTEA (Japan Cable Television Engineering Association)	TTA
OIF (Optical Internetworking Forum)	MPLS Forum	TTC
OMG (Object Management Group)	NIST (National Institute of Standards and Technology)	
SDL Forum Society	OASIS	
TM Forum (Tele Management Forum)	OIF	
W3C (World Wide Web Consortium)	OMG	
	SCTE (Society of Cable Telecommunications Engineers)	
	TIA (Telecommunications Industry Association)	
	TM Forum	
	TTA (Telecommunications Technology Association)	
	TTC (Telecommunication Technology Committee)	
	W3C	

Slovenski Inštitut za Standardizacijo

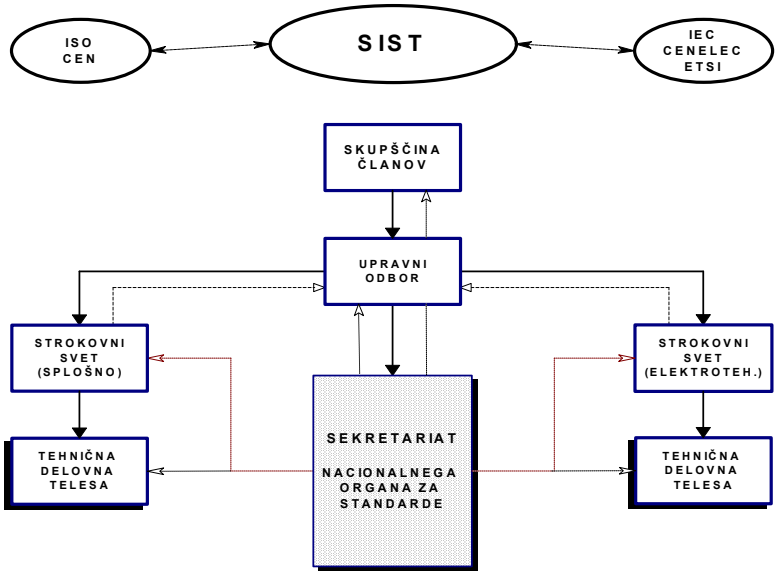
SIST
SLOVENSKI INŠTITUT ZA STANDARDIZACIJO

Dejavnosti

- opravlja dejavnost slovenske nacionalne standardizacije
- vzpostavlja, vodi in vzdržuje nacionalni sistem standardizacije
- zagotavlja slovenske nacionalne in druge standarde
- predstavlja Slovenijo v mednarodnih in evropskih organizacijah za standardizacijo
- strokovno svetuje pri uporabi standardov
- je mednarodno priznan nacionalni organ za standarde na področju elektrotehnike (IEC, CENELEC), telekomunikacij (ETSI) in splošne standardizacije (ISO, CEN)

- Prej Slovenski urad za standardizacijo in meroslovje v okviru Ministrstva za znanost in tehnologijo; od leta 2000 samostojna organizacija

Organiziranost SIST



Slovenski nacionalni standard

- SIST - oznaka slovenskega nacionalnega standarda
- Prevzemanje mednarodnih in evropskih standardov v slovenskem ali tujem jeziku
- Podatki o sprejetem SIST objavljeni v e-glasilu Inštituta
- SIST kot posebna publikacija je avtorsko delo, skladno s predpisi o avtorski pravici
- Uporaba SIST je prostovoljna
- Predpis, ki določa obvezno uporabo standarda, se mora sklicevati na SIST

Glede na izvor ločimo :

- izvirni standard
- privzeti mednarodni standard
- privzeti evropski standard
- privzeti tuji nacionalni standard

Označevanje SIST dokumentov

Označevanje slovenskih nacionalnih standardov

- **SIST XXXX**
- **SIST ISO 8421-3**
- **SIST EN 1147**
- **SIST DIN 14090**
- **SIST 1013:1996**
- **SIST EN 1147:2001**

Pri sklicevanju ali navajanju oznak brez letnice se upošteva njihova zadnja izdaja.

Tehnični odbor

- Sestava: zainteresirane strani (proizvajalci, potrošniki, državni organi, zbornice, izobraževalne ustanove, certifikacijski organi)
- Članstvo: pisna prijava in pristopna izjava
- Pravice in ugodnosti:
  - sodeluje v TC
  - lahko vpliva na vsebino standardov
  - zastopa nacionalne interese v mednarodni in evropski standardizaciji
  - dostop do informacij, ki drugače niso prosto dostopne

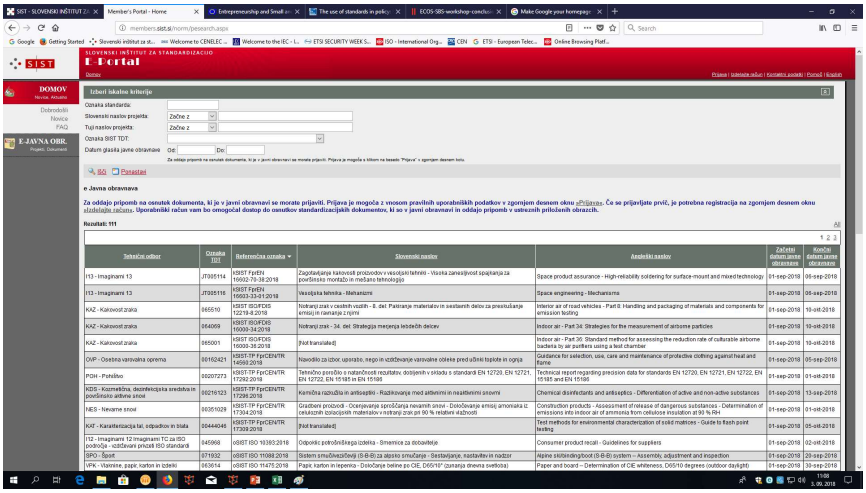
Seznam SIST TC-jev s področja EIT

TDT	Ime TDT	Predsednik TDT
TC AVM	Avdio, video in večpredstavitveni sistemi ter njihova oprema	Fajdiga Matjaž univ. dipl. inž. el.
TC CEV	Cestna osebna in gospodarska električna vozila	Levstek Miha
TC DPN	Delo pod napetostjo	Mag. Lovrenčič Viktor
TC EAL	Električni alarmi	Prof. Dr. Fefer Dušan
TC EDO	Elektrotehniška dokumentacija	Mag. Matič Zlatko
TC ELI	Nizkonapetostne in komunikacijske električne inštalacije	Kotnik Marko univ. dipl. inž. el.
TC EMC	Elektromagnetna združljivost	Mag. Matvoz Dejan
TC EPR	Električni pribor	Koprivšek Mitja
TC ERS	Električni rotacijski stroji	Prof. Dr. Zagradišnik Ivan
TC ETR	Energetski transformatorji	Istok Jerman Kuželički
TC EVA	Električne varovalke	Martinčič Viktor
TC EXP	Električni aparati za eksplozivne atmosfere	Debenc Matej univ. dipl. fiz.
TC FGA	Funkcionalnost gospodinjskih aparatov	Nejc Hriberšek
TC GIG	Geografske informacije	Simon Vrečar
TC IDT	Informatika, dokumentacija in splošna terminologija	Mag. Bahor Stanislav
TC ITC	Informacijska tehnologija	Prof. Dr. Jerman Blažič Borka
TC IZL	Izolatorji	Miha Bečan
TC MEE	Oprema za merjenje električne energije in krmiljenje obremenitve	Drago Hafner
TC MOC	Mobilne komunikacije	Majcen Drago univ. dipl. inž.
TC MOV	Merilna oprema za elektromagnetne veličine	Mag. Seliger Bogdan
TC NTF	Oskrba z električno energijo	Mag. Bergant Peter
TC NVV	Nadzemni vodi in vodniki	Mag. Bakić Krešimir
TC POD	Prenapetostni odvodniki	Mag. Pirih Andrej
TC PSE	Procesni sistemi v energetiki	Souvent Andrej univ. dipl. inž.
TC PVS	Fotonapetostni sistemi	Denis Lenardič
TC SKA	Stikalni in krmilni aparati	Mag. Marčun Marko
TC SPN	Storitve in protokoli v omrežjih	Mag. Hudobivnik Alojz
TC STZ	Zaščita pred delovanjem strele	Dr. Žitnik Boris
TC TPD	Tekoči in plinasti dielektriki	Mag. Maja Končan Gradnik
TC TRM	Terminologija	Unk Jože
TC VGA	Varnost električnih aparatov za gospodinjstvo in podobne namene	Jeromel Igor univ. dipl. inž. el.
TC ŽEN	Železniške električne naprave	Erzar Stane

Strokovni svet SIST za elektrotehniko, informacijsko tehnologijo in telekomunikacije (2019-23)

Spletna stran SIST

Dostop do dokumentov (e-katalog, javna obravnava (30 dni!))



KAKO SLOVENIJA SODELUJE?

ITU

- ***SIST je po pooblastilu Vlade RS oblikoval delovno skupino zainteresiranih predstavnikov, ki spremljajo standardizacijsko delo in hodijo na zasedanja. AKOS v okviru svojih področij spremlja delo (ITU-R)***

  Delo je volontersko. Konstruktivnih predlogov, pobud je malo. Na generalnem nivoju se vključuje* Ministrstvo za javno upravo *(*Direktorat za informacijsko družbo*).

ETSI

- ***SIST ima delovne volonterske skupine, ki spremljajo delo ETSI. V preteklosti so po programu harmonizacije z EU prevzele ETSI dokumente v SIST sistem. Prevaja se samo naslov. Sedaj so člani skupin aktivni v pripravi dokumentov in pri glasovanju. ETSI EN- dokument postane SIST EN-dokument.***

IETF

- ***Sodelovanje je prepuščeno posameznikom – ekspertom.***

SINTESIO

Odprt NGN testni laboratorij

- Direktor Dr. Roman Kužnar

Laboratorij za telekomunikacije Fakulteta za elektrotehniko

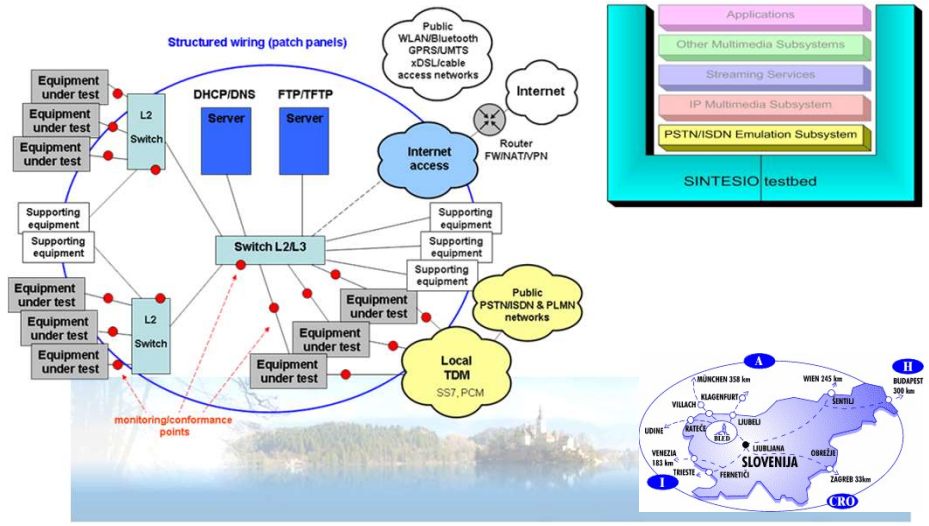
SIST

ISKRATEL

Povzetek SINTESIO

- **SINTESIO:**
  - NGN testni laboratorij (neprofitni, odobren pri ETSI)
  - Lokacija Kranj (prej Bled)
  - Poudarek na klicnih strežnikih, medijskih in signalizacijskih prehodih.
- **Namen:**
  - Izvajanje interoperabilnih testov.
  - Povratna informacija standarizacijskim telesom.
  - Izobraževanja na temo interoperabilnosti.
- **Koristi:**
  - Proizvajalci
  - Operaterji
  - Raziskovalci
  - Standarizacijska telesa
  - Končni uporabniki

Testna infrastruktura



2. DEL

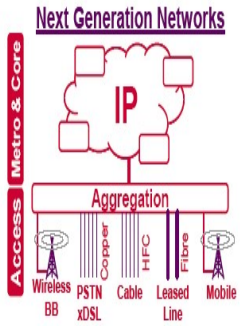
Aktualne teme na področju IKT standardizacije

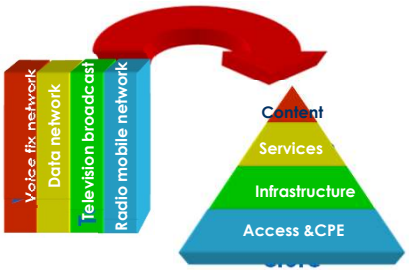
- **„Future networks“ standardizacija**
- **Standardizacija 5G in naprej ….**

2020 - Copyright mag. Alojz Hudobivnik

Trenutna arhitektura iz 2001: NGN – definicija

- Omrežje naslednje generacije (NGN) je paketno omrežje, ki poleg ostalega zagotavlja telekomunikacijske storitve
- Omrežje omogoča uporabo različnih širokopasovnih tehnologij, ki podpirajo kakovost storitve (QoS) in pri katerih so funkcije, povezane s storitvami, neodvisne od transportnih tehnologij.
- Uporabnikom omogoča neomejen dostop do različnih ponudnikov storitev.
- Omrežje podpira generalizirano mobilnost, ki bo omogočila splošno zagotavljanje storitev uporabnikom kjer koli.





63

Fakulteta za elektrotehniko, Univerza v Ljubljani

SPREMEMBE SE DOGAJAJO: IoT/M2M

- 1 Mlrd fiksnih naročnikov/priključkov
- 6 Mlrd mobilnih naročnikov
- 50 Mlrd naprav v kratkem za dvig produktivnosti v različnih industrijskih sektorjih

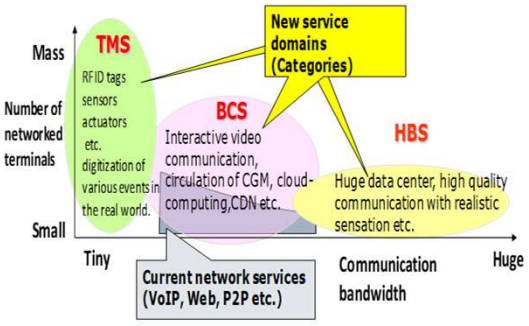
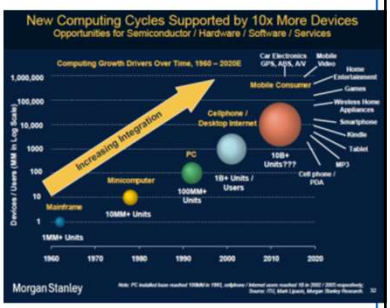
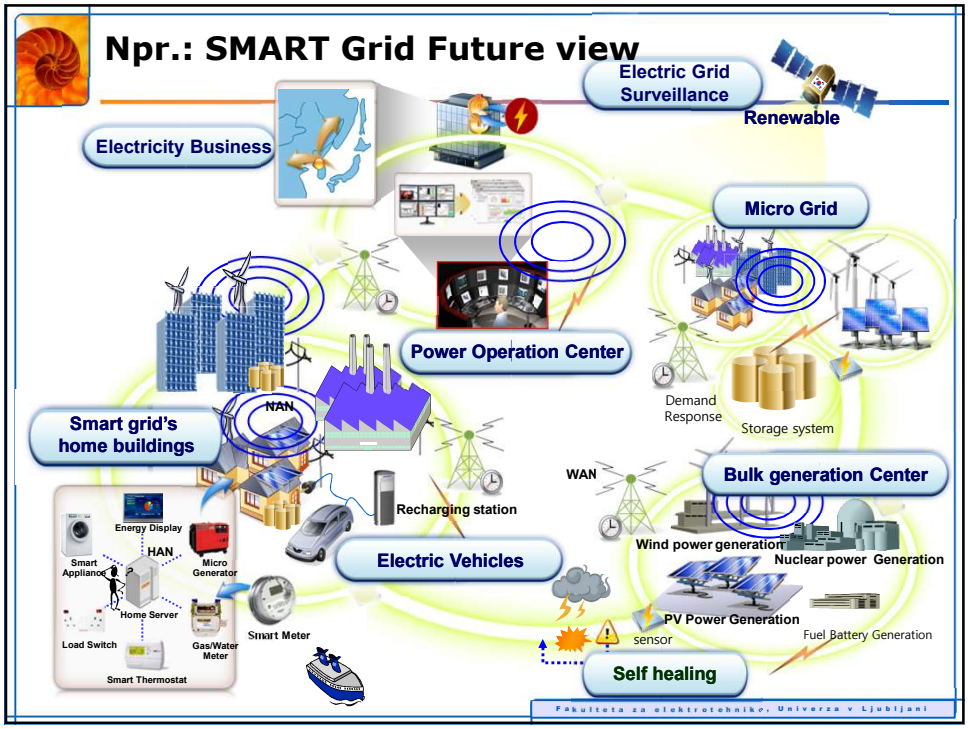
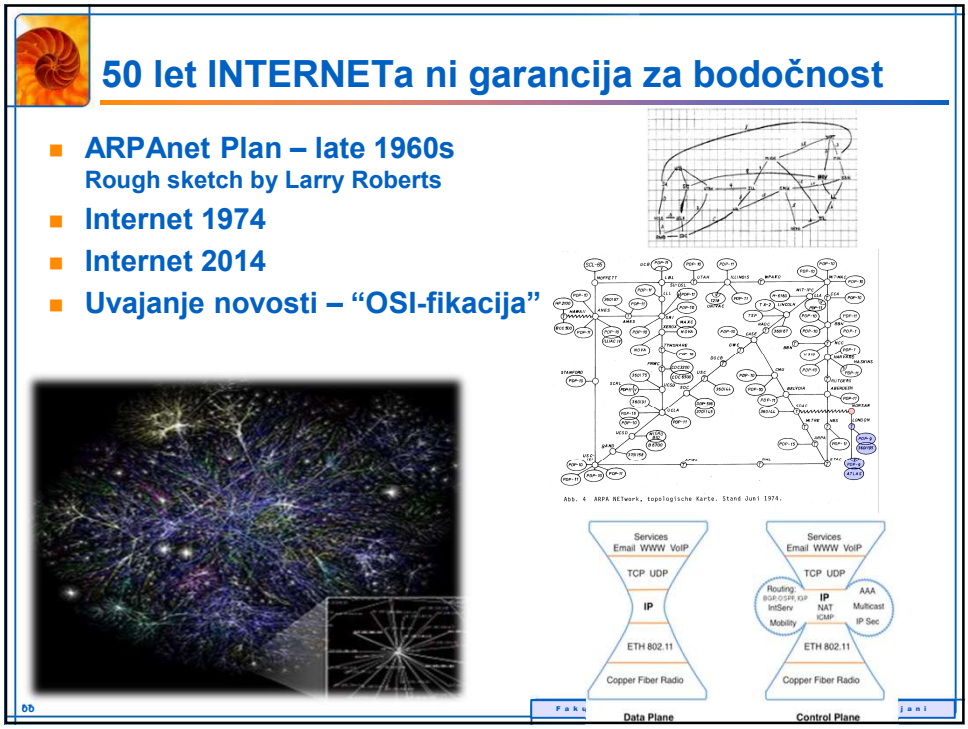


Fig.1 Classification of network services in the future



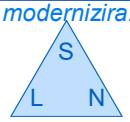
Fakulteta za elektrotehniko, Univerza v Ljubljani


Npr.: SMART Grid Future view
Electric Grid Surveillance
Renewable
Electricity Business
Micro Grid
Power Operation Center
Demand Response
Storage system
NAN
Smart grid's home buildings
WAN
Bulk generation Center
Recharging station
Energy Display
HAN
Micro Generator
Smart Appliance
Home Server
Load Switch
Gas/Water Meter
Smart Thermostat
Smart Meter
Electric Vehicles
Wind power generation
Nuclear power Generation
PV Power Generation
sensor
Fuel Battery Generation
Self healing
Fakulteta za elektrotehniko, Univerza v Ljubljani


50 let INTERNETa ni garancija za bodočnost
ARPAnet Plan – late 1960s
Rough sketch by Larry Roberts
Internet 1974
Internet 2014
Uvajanje novosti – "OSI-fikacija"
Abb. 4 ARPA NETwork, topologische Karte, Stand Juni 1974.
Services
Email WWW VoIP
TCP UDP
IP
ETH 802.11
Copper Fiber Radio
Data Plane
Routing:
IntServ
Mobility
NAT
ICMP
AAA
Multicast
IP Sec
Control Plane

Nova arhitektura != nova storitev

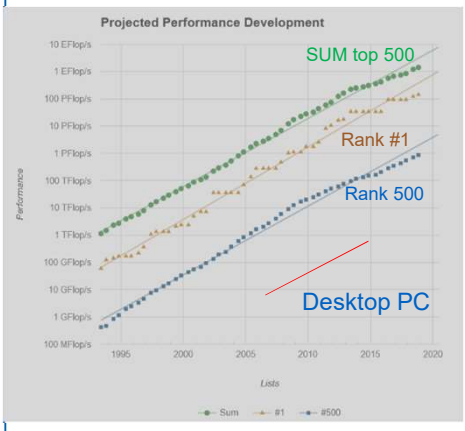
Ne pozabi: Pri vodooskrbi je izdelek vedno enak (pitna voda), omrežje se modernizira!



- **Nova arhitektura postane potrebna, ko se spremeni ravnovesje med ključnimi elementi (prenos, obdelava-vozlišče, pomnjenje):**
  - **Cena povezave napram ceni vozlišča: optična vlakna so drastično zmanjšala stroške povezave, zato so vozlišča manj kompleksna in komunikacija med njimi bolj intenzivna (tekst, kontrolna sporočila)**
  - **Cena diskov (pomnilnika) se še vedno zmanjšuje**
- **Nova storitev nastane, ko se pojavi nova uporabniška naprava**
  - **Personal Computer (PC) → internet**
  - **Mobile phone → made everything personal**
  - **Bigger computer (Data center) → cloud (GFLOPS history)**
  - **Cheap sensors → M2M**

Fakulteta za elektrotehniko, Univerza v Ljubljani

Razvoj zmogljivosti super-računalnikov

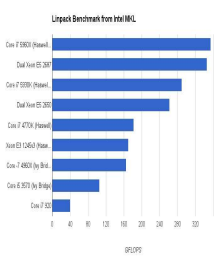


IBM Blue Gene
250,000 processors using normal data center air conditioning, grouped in 72 racks/cabinets connected by a high-speed optical network

1. Summit DOE (IBM POWER9)(USA) 2,4Mcores, 2801PBytes, 9,7MW, 148,6PF

3. Sunway MPP (Sunway)(CHN) 10 Mcores, 15,7MW, 93,0PF

Soure: Top500-11/2018

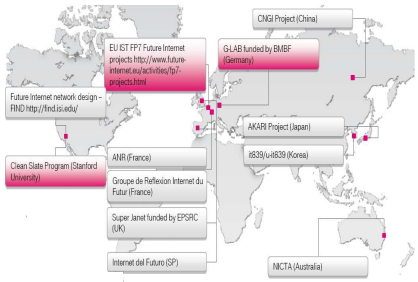


2020: Sony PlayStation5 10,28TFlops
2019: Intel i10 1TFlops (GPU!)
Iphone7 procesor: cca 300GFlops
1984: Cray-X 1GFlops

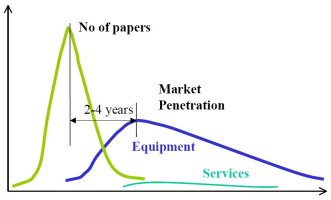
20-4-2020 68/102

Fakulteta za elektrotehniko, Univerza v Ljubljani 68

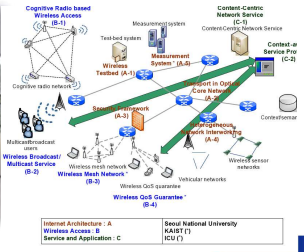
RAZISKAVE PO SVETU



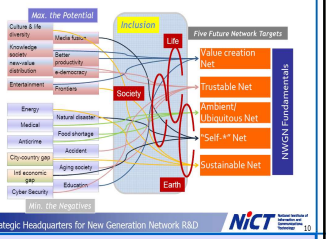
Evolution of Papers in Engineering Conferences



ORBIT, Rutgers WINLAB



NwGN: From Visions to Targets



Strategic Headquarters for New Generation Network R&D

69

Fakulteta za elektrotehniko, Univerza v Ljubljani

STANDARDIZACIJA SE JE PREBUDILA

ITU-T 2009 začne s pred-standardizacijskimi aktivnostmi - identifikacija FNs zahtev (Q.21/SG13) – enako tudi ISO JTC1/SC6

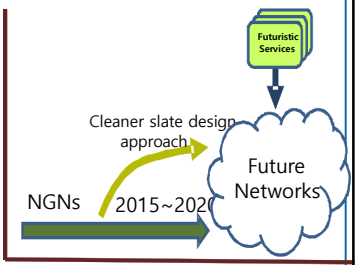
Future Networks

- **nove družbeno/ekonomske/socialne zahteve (e.g., okolje, poslovni modeli),**
- **nova aplikacijska področja(e.g., IoT, cloud, smart grid),**
- **nove tehnologije in principi**

Usmeritev in vsebina je črpana iz pregleda in rezultata obstoječih raziskovalnih aktivnosti po svetu (Azija, EU, USA) (ni še vendorjev, operaterjev)

Izdelan je bazični dokument ITU-T Y.3001 **Future Networks: Objectives and Design Goals** in prvi FNs "priročnik" (1/2011)

Časovno je nadaljni razvoj planiran tako, da je v naslednji fazi dano dovolj časa raziskovalcem, da najdejo najboljše odgovore na zahteve.



70

Fakulteta za elektrotehniko, Univerza v Ljubljani

Rezultati dela - Future networks

- **Način delovanja FG Future networks (6-2009…12-2010)**
  - **8 sestankov, zaključni je bil v Ljubljani 29.11-3.12.2010 +WS**
- **Rezultati v Q21/13 (2011,2012):**
  - **Y.3001: *Future networks: Objectives and design goals***
  - **Y.3011: *Framework of network virtualization for future networks***
  - **Y.3021: *Framework of energy saving for future networks***
  - **Y.3031: *Identification framework in future networks***

**** Članek IEEE Communication oz. Elektrotehniški vestnik***

Omrežje prihodnosti – stališče ITU-T (6/2013) v slo http://ev.fe.uni-lj.si/online.php?vol=80&n=1-2

Kako se zgodba odvija naprej:

- **V obdobju 2013-2016 se je delo razdelilo na tri nova Q(14,15,16)/13**
  - **ITU-T Y.3300, "Framework of Software-Defined Networking", 4/2014**
  - **ITU-T Y.3012 (Y.FNvirtreq) „Requirements of network virtualization for future networks", 4/2014**
  - **ITU-T Y.3032, "Configurations of node identifiers and their mapping with locators in future networks", 1/2014**
  - **ITU-T Y.3033, "Framework of data aware networks for Future Networks", 6/2014**

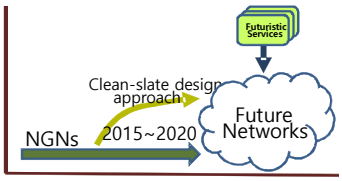
Vision of Future Networks (ITU-T Y.3001 (5/2011))

Definicija omrežja prihodnosti:

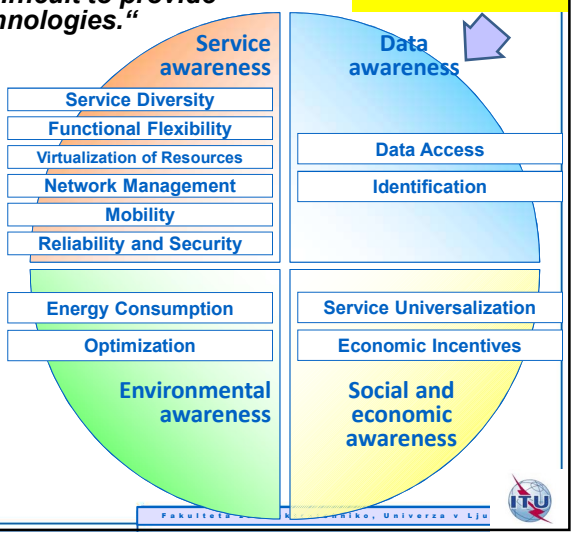
„ A network able to provide services, capabilities, and facilities difficult to provide using existing network technologies."

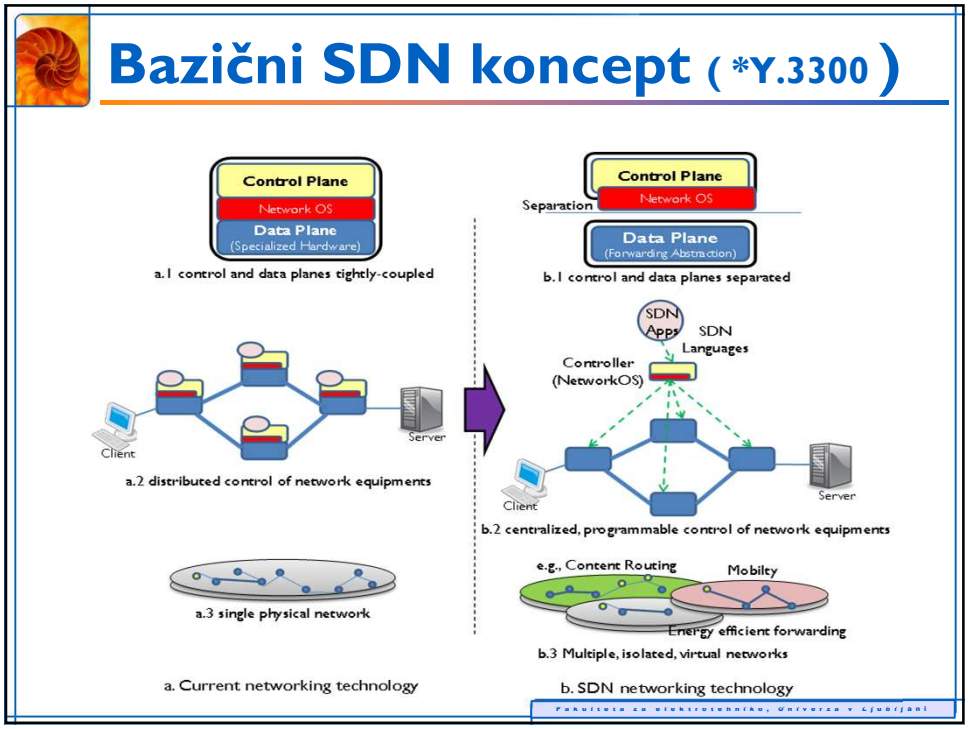
A Future Network is either:

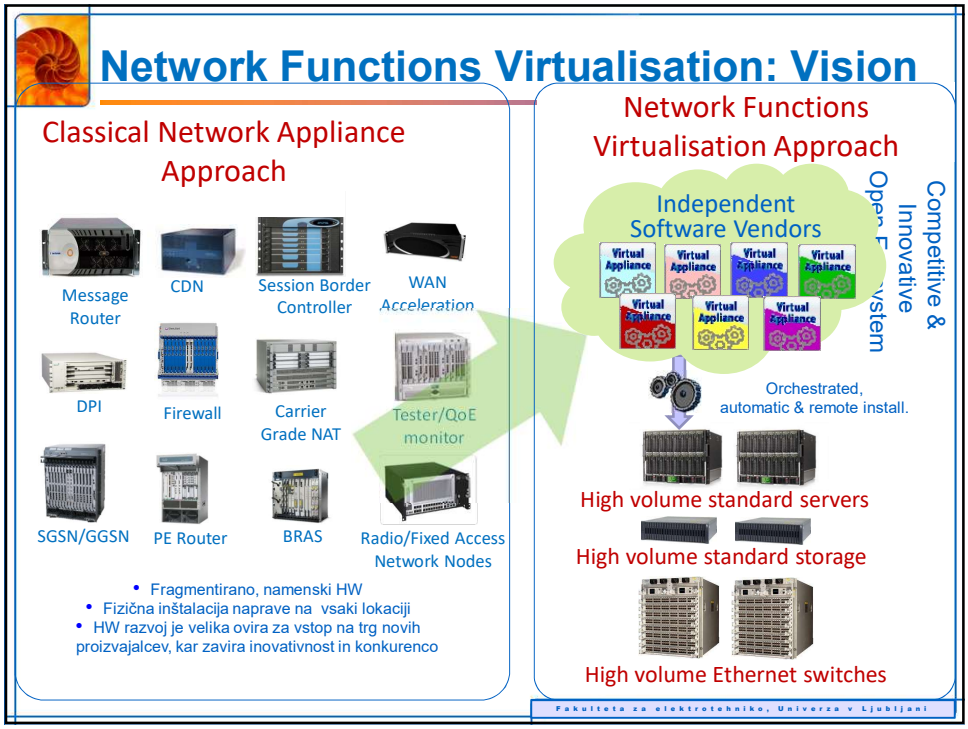
- *a) A new component network or an enhanced version of an existing one, or*
- *b) A heterogeneous collection of new component networks or of new and existing component networks that is operated as a single network.*

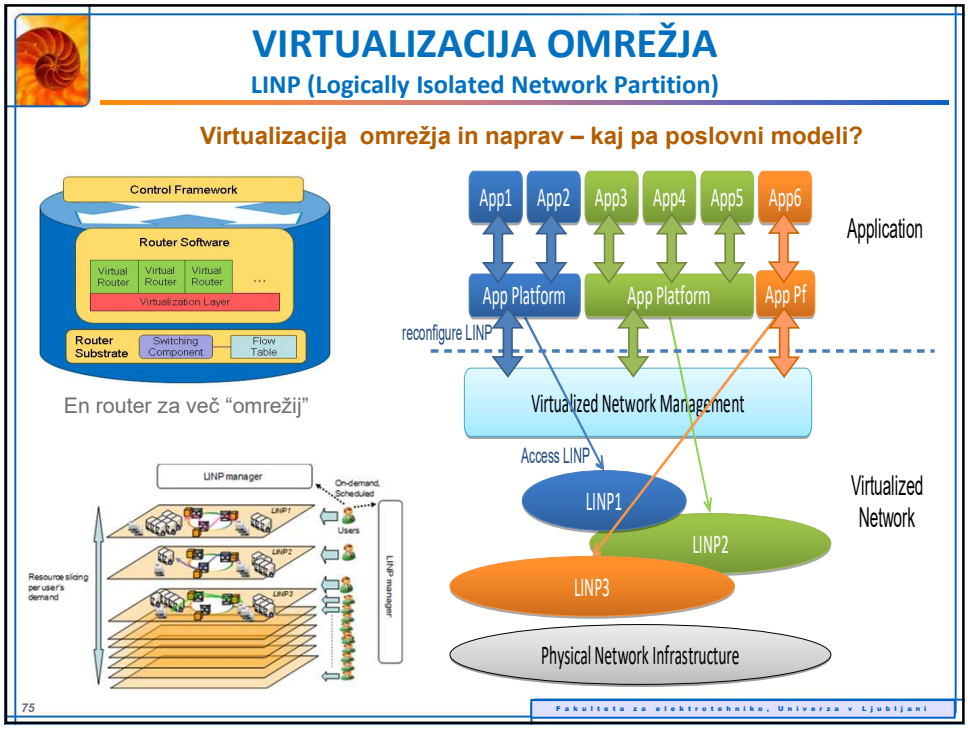


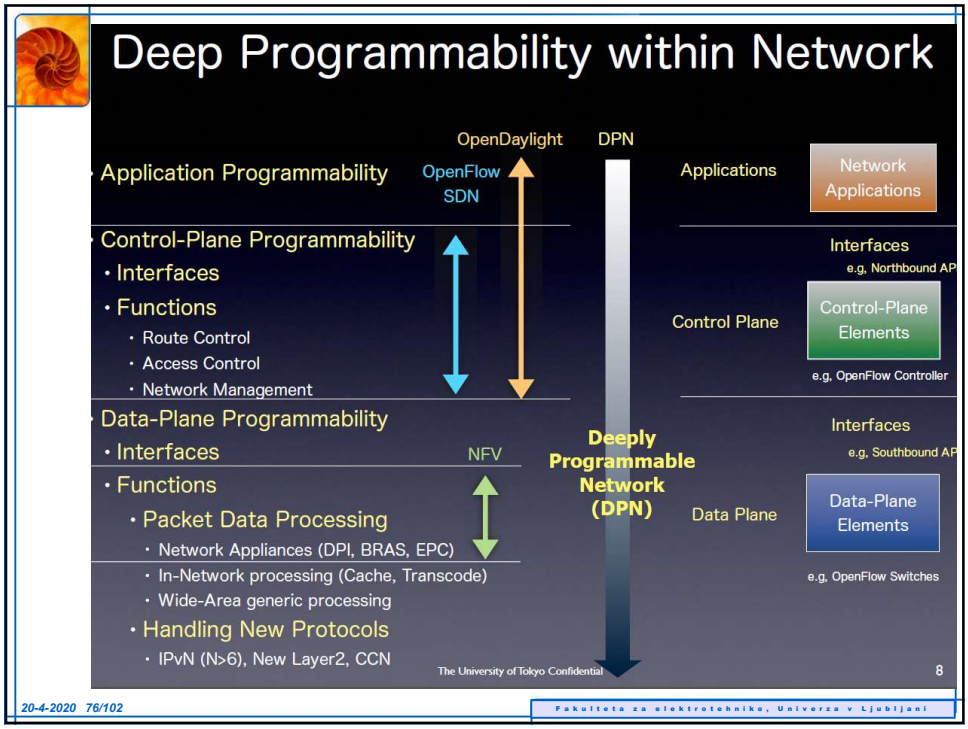
4 cilji in 12 usmeritev



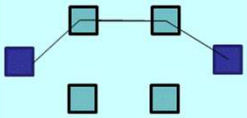
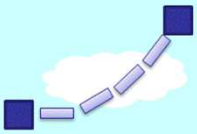
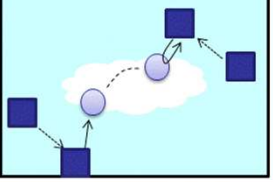

Bazični SDN koncept (*Y.3300)
Control Plane
Network OS
Data Plane
(Specialized Hardware)
a.1 control and data planes tightly-coupled
Separation
Control Plane
Network OS
Data Plane
(Forwarding Abstraction)
b.1 control and data planes separated
Client
Server
a.2 distributed control of network equipments
SDN Apps
SDN Languages
Controller (NetworkOS)
Client
Server
b.2 centralized, programmable control of network equipments
a.3 single physical network
e.g., Content Routing
Mobilty
Energy efficient forwarding
b.3 Multiple, isolated, virtual networks
a. Current networking technology
b. SDN networking technology


Network Functions Virtualisation: Vision
Classical Network Appliance Approach
Message Router
CDN
Session Border Controller
WAN Acceleration
DPI
Firewall
Carrier Grade NAT
Tester/QoE monitor
SGSN/GGSN
PE Router
BRAS
Radio/Fixed Access Network Nodes
• Fragmentirano, namenski HW
• Fizična inštalacija naprave na vsaki lokaciji
• HW razvoj je velika ovira za vstop na trg novih proizvajalcev, kar zavira inovativnost in konkurenco
Network Functions Virtualisation Approach
Independent Software Vendors
Virtual Appliance
Orchestrated, automatic & remote install.
High volume standard servers
High volume standard storage
High volume Ethernet switches
Competitive & Innovative


VIRTUALIZACIJA OMREŽJA
LINP (Logically Isolated Network Partition)
Virtualizacija omrežja in naprav – kaj pa poslovni modeli?
Control Framework
Router Software
Virtual Router
Virtual Router
Virtual Router
Virtualization Layer
Router Substrate
Switching Component
Flow Table
En router za več "omrežij"
App1
App2
App3
App4
App5
App6
Application
App Platform
App Platform
App Pf
reconfigure LINP
Virtualized Network Management
Access LINP
LINP1
LINP2
LINP3
Virtualized Network
Physical Network Infrastructure
LINP manager
On-demand, Scheduled
Users
Resource slicing per user's demand
75
Fakulteta za elektrotehniko, Univerza v Ljubljani

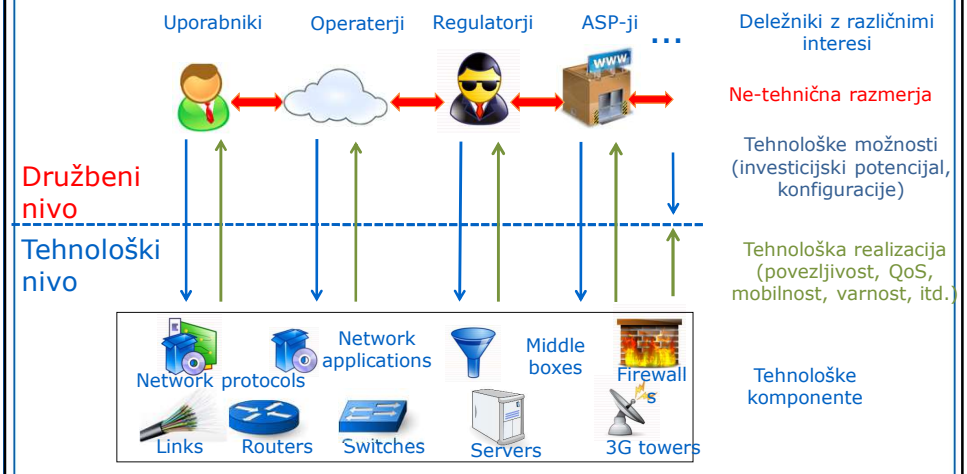

Deep Programmability within Network
OpenDaylight
DPN
Application Programmability
OpenFlow
SDN
Applications
Network Applications
Control-Plane Programmability
• Interfaces
• Functions
• Route Control
• Access Control
• Network Management
Interfaces
e.g, Northbound AP
Control Plane
Control-Plane Elements
e.g, OpenFlow Controller
Data-Plane Programmability
• Interfaces
• Functions
• Packet Data Processing
• Network Appliances (DPI, BRAS, EPC)
• In-Network processing (Cache, Transcode)
• Wide-Area generic processing
• Handling New Protocols
• IPvN (N>6), New Layer2, CCN
NFV
Deeply Programmable Network (DPN)
Interfaces
e.g, Southbound AP
Data Plane
Data-Plane Elements
e.g, OpenFlow Switches
The University of Tokyo Confidential
8
20-4-2020 76/102
Fakulteta za elektrotehniko, Univerza v Ljubljani

Examples: ICN/DCN Concept

	PSTN(telephony)	IP(Internet)	Data Centric Network
Time	1930's -	1980's -	2020's -
Usage	voice communication	WEB	M2M
Type of Communication	Human to Human	Human to Machine	Machine to Machine
Infrastructure	circuit switching	packet switching	object distribution
Strength	QoS	connectivity	mobility
Weakness	efficiency	reliability, QoS, mobility	delay
Mechanism	Sender specifies terminal ID(phone number) and set-up end-to-end circuit passage. 	Sender specifies terminal location (IP address) and send out packet flows. 	Sender registers an object with an ID attached, and receiver specifies the ID to retrieve it. 

Fakulteta za elektrotehniko, Univerza v Ljubljani

Socio-economic Awareness (zavedanje)



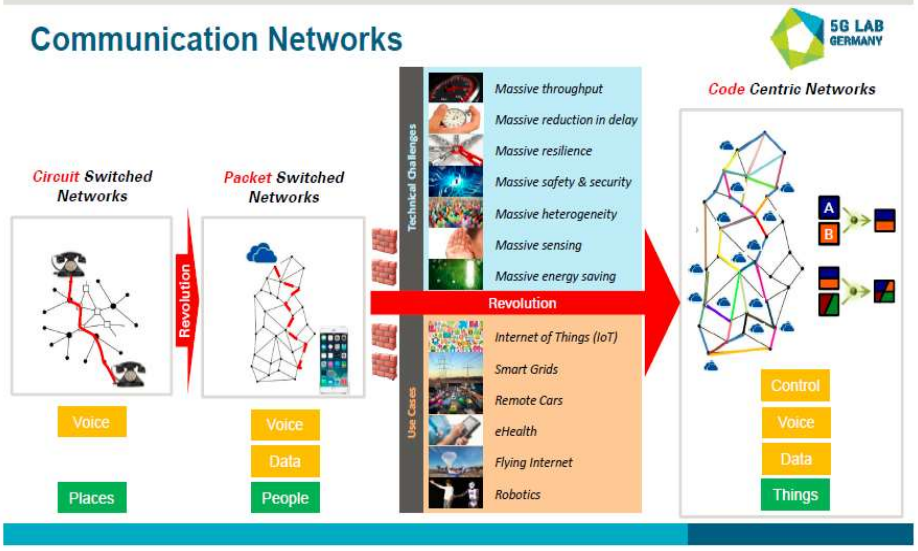
Soc-ekonomski nivo → **„parlamentarni" zakoni** (nac./regio./glob.)
tehnološki nivo → **zakoni fizike**

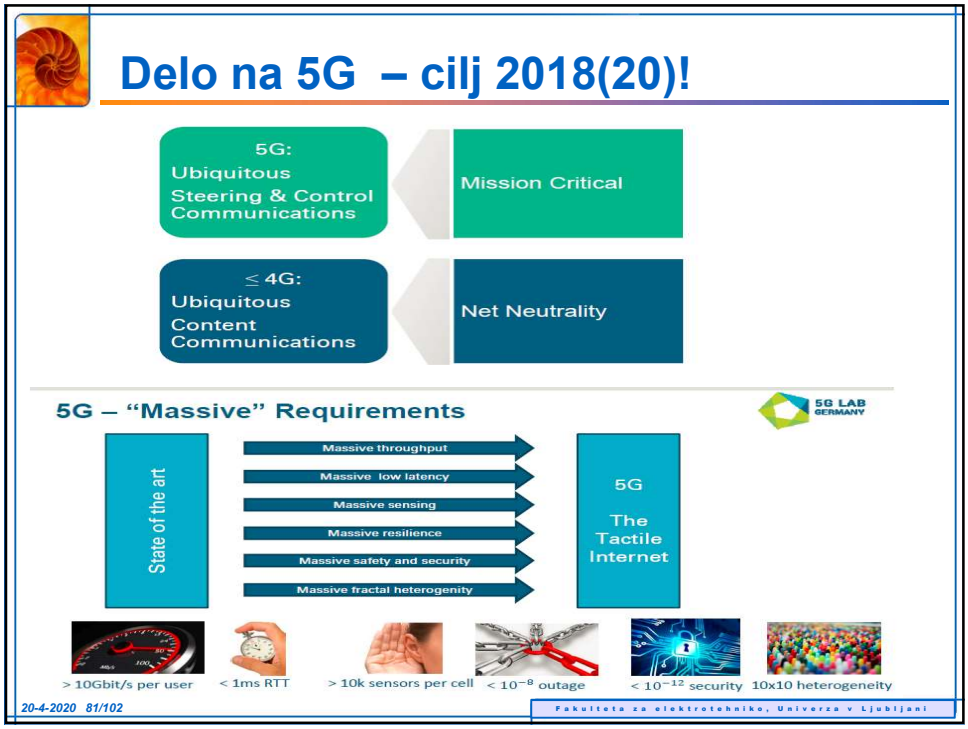
Fakulteta za elektrotehniko, Univerza v Ljubljani

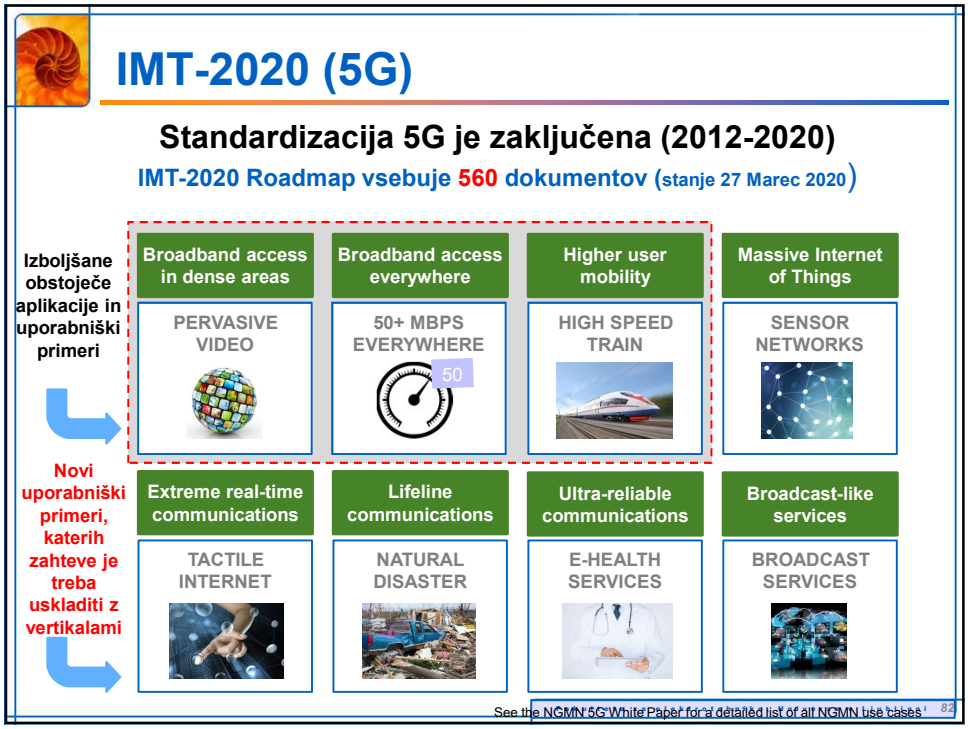
FN: Ključne ugotovitve

- **Izzivi: nove družbene zahteve (npr. okolje), nova področja uporabe (npr. internet stvari (IoT), oblaki (Cloud) pametno omrežje (Smart grid)), najdene so nove tehnologije za izvedbo**
  - **To uvaja nove arhitekture omrežja, čemur pravimo Omrežje bodočnosti**
- **Časovni okvir za uvajanje: 2015-2020 (delno v 5G…)**
- **Možni diferenciator FN od obstoječe omrežne arhitekture**
  - ***Service awareness;* kako upravljati velike količine izjemno različnih storitev?**
  - ***Data awareness*; današnja omrežja se uporablja predvsem za dostop do podatkov, vendar niso bila koncipirana za to**
  - ***Environment awareness*; 'iz omrežja' in 'z omrežjem'**
  - ***Social-economic awareness*; arhitektura mora biti pozorna na vpliv socialnih in gospodarskih vprašanj, na primer univerzializacije, nadgradljivosti ali storitvene univerzalnosti**
- **Za oblikovanje FN je potrebno širše sodelovanje, kot je bilo potrebno v tradicionalnem IKT okviru.**
  - **Današnja obetajoča področja so vsa interdisciplinarna med IKT in drugimi industrijami (Cloud: računalniška, smart grid: elektro, IoT: zdravstvo, promet, itd.)**
  - **IKT je postaja infrastruktura vsaki industriji, zato moramo dobro poznati njihove potrebe za oblikovanje primernega omrežja bodočnosti. Ne moremo npr. načrtovati pametnih omrežij brez razumevanja elektroindustrije in njenih zahtev.**

Razvoj omrežij ... trenutni status je 5G




Delo na 5G – cilj 2018(20)!
5G:
Ubiquitous
Steering & Control
Communications
Mission Critical
≤ 4G:
Ubiquitous
Content
Communications
Net Neutrality
5G – "Massive" Requirements
5G LAB GERMANY
State of the art
Massive throughput
Massive low latency
Massive sensing
Massive resilience
Massive safety and security
Massive fractal heterogenity
5G
The
Tactile
Internet
> 10Gbit/s per user
< 1ms RTT
> 10k sensors per cell
< 10⁻⁸ outage
< 10⁻¹² security
10x10 heterogeneity
20-4-2020 81/102
Fakulteta za elektrotehniko, Univerza v Ljubljani


IMT-2020 (5G)
Standardizacija 5G je zaključena (2012-2020)
IMT-2020 Roadmap vsebuje 560 dokumentov (stanje 27 Marec 2020)
Izboljšane obstoječe aplikacije in uporabniški primeri
Broadband access in dense areas
Broadband access everywhere
Higher user mobility
Massive Internet of Things
PERVASIVE VIDEO
50+ MBPS EVERYWHERE
50
HIGH SPEED TRAIN
SENSOR NETWORKS
Novi uporabniški primeri, katerih zahteve je treba uskladiti z vertikalami
Extreme real-time communications
Lifeline communications
Ultra-reliable communications
Broadcast-like services
TACTILE INTERNET
NATURAL DISASTER
E-HEALTH SERVICES
BROADCAST SERVICES
See the NGMN 5G White Paper for a detailed list of all NGMN use cases

ITU-T

FG IMT-2020 (5-2015 do 12-2015, +2016)

- Analiza zahtev za fiksni del 5G omrežja
  (ITU-R deluje na področju radijskih komunikacij)
- Kaj je potrebno dodelati na področju standardizacije
- Ključna področja „gap“ analize:
  - High level network architecture
  - Network softwarization
  - End-to-End QoS
  - Front haul/back haul
  - Emerging Network Technologies
- Skupaj zaznano in opredeljeno 85 vrzeli

Projekt se je večinsko zaključil, pilotna 5G omrežja so razširjena po svetu (npr. Beljak, A). Prvo nacionalno komercijalno omrežje – J.Koreja (4-4-2019)

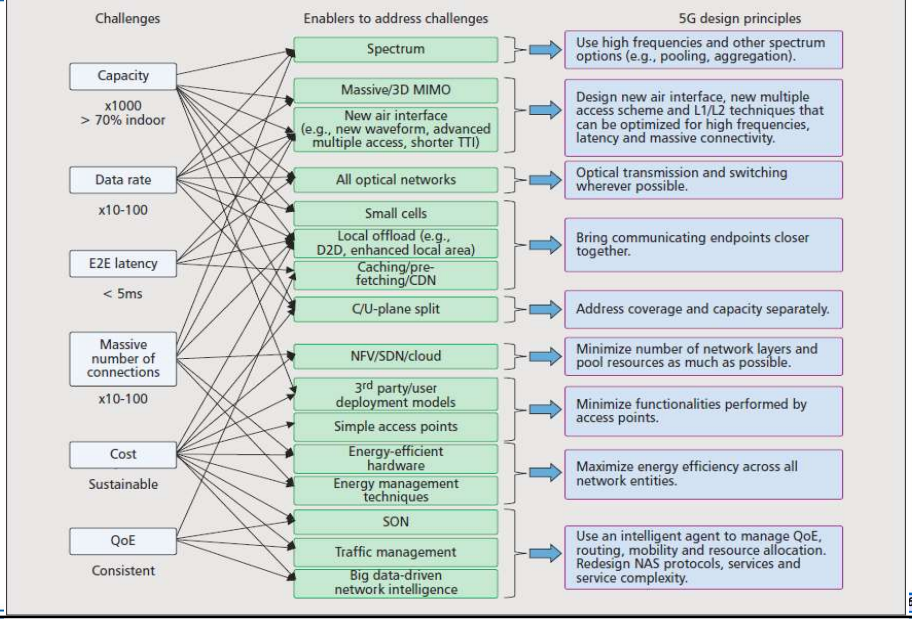
5G KPI – uporabniška izkušnja

Use case category	User Experienced Data Rate	E2E Latency	Mobility
Broadband access in dense areas	DL: 300 Mbps UL: 50 Mbps	10 ms	On demand, 0-100 km/h
Indoor ultra-high broadband access	DL: 1 Gbps, UL: 500 Mbps	10 ms	Pedestrian
Broadband access in a crowd	DL: 25 Mbps UL: 50 Mbps	10 ms	Pedestrian
50+ Mbps everywhere	DL: 50 Mbps UL: 25 Mbps	10 ms	0-120 km/h
Ultra-low cost broadband access for low ARPU areas	DL: 10 Mbps UL: 10 Mbps	50 ms	on demand: 0-50 km/h
Mobile broadband in vehicles (cars, trains)	DL: 50 Mbps UL: 25 Mbps	10 ms	On demand, up to 500 km/h
Airplanes connectivity	DL: 15 Mbps per user UL: 7.5 Mbps per user	10 ms	Up to 1000 km/h
Massive low-cost/long-range/low-power MTC	Low (typically 1-100 kbps)	Seconds to hours	on demand: 0-500 km/h
Broadband MTC	See the requirements for the Broadband access in dense areas and 50+Mbps everywhere categories		
Ultra-low latency	DL: 50 Mbps UL: 25 Mbps	<1 ms	Pedestrian
Resilience and traffic surge	DL: 0.1-1 Mbps UL: 0.1-1 Mbps	Regular communication: not critical	0-120 km/h
Ultra-high reliability & Ultra-low latency	DL: From 50 kbps to 10 Mbps; UL: From a few bps to 10 Mbps	1 ms	on demand: 0-500 km/h
Ultra-high availability & reliability	DL: 10 Mbps UL: 10 Mbps	10 ms	On demand, 0-500 km/h
Broadcast like services	DL: Up to 200 Mbps UL: Modest (e.g. 500 kbps)	<100 ms	on demand: 0-500 km/h

5G KPI – sistemske zmogljivosti

Use case category	Connection Density	Traffic Density
Broadband access in dense areas	200-2500 /km^2	DL: 750 Gbps / km2 UL: 125 Gbps / km2
Indoor ultra-high broadband access	75,000 / km^2 (75/1000 m^2 office)	DL: 15 Tbps/ km2 (15 Gbps / 1000 m2) UL: 2 Tbps / km2 (2 Gbps / 1000 m2)
Broadband access in a crowd	150,000 / km^2 (30.000 / stadium)	DL: 3.75 Tbps / km2 (DL: 0.75 Tbps / stadium) UL: 7.5 Tbps / km2 (1.5 Tbps / stadium)
50+ Mbps everywhere	400 / km^2 in suburban 100 / km^2 in rural	DL: 20 Gbps / km2 in suburban UL: 10 Gbps / km2 in suburban DL: 5 Gbps / km2 in rural UL: 2.5 Gbps / km2 in rural
Ultra-low cost broadband access for low ARPU areas	16 / km^2	16 Mbps / km^2
Mobile broadband in vehicles (cars, trains)	2000 / km^2 (500 active users per train x 4 trains, or 1 active user per car x 2000 cars)	DL: 100 Gbps / km^2 (25 Gbps per train, 50 Mbps per car) UL: 50 Gbps / km^2 (12.5 Gbps per train, 25 Mbps per car)
Airplanes connectivity	80 per plane 60 airplanes per 18,000 km^2	DL: 1.2 Gbps / plane UL: 600 Mbps / plane
Massive low-cost/long-range/low-power MTC	Up to 200,000 / km^2	Non critical
Broadband MTC	See the requirements for the Broadband access in dense areas and 50+Mbps everywhere categories	
Ultra-low latency	Not critical	Potentially high
Resilience and traffic surge	10,000 / km^2	Potentially high
Ultra-high reliability & Ultra-low latency* (*) the reliability requirement for this category is described in Section 4.4.5	Not critical	Potentially high
Ultra-high availability & reliability* (*) the reliability requirement for this category is described in Section 4.4.5	Not critical	Potentially high
Broadcast like services	Not relevant	Not relevant

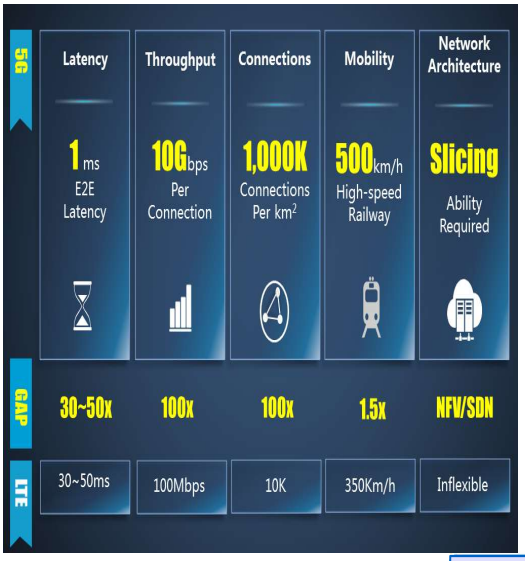
Izzivi in priporočila pri snovanju 5G



Orodja: programabilnost omrežja je No.1

- Network Softwarization
  - Network Virtualization
  - Network Functions Virtualisation (NFV)
  - Software Defined Networking (SDN)
  - Network Programmability
  - SDN distribuded cloud
- In-network processing
- Smart edge nodes to reduce latency
- Micro-servers
- Information-Centric Networking (ICN)/Content –CN
- Scalable service architecture
- Big data

Povzetek - tehnični izzivi za doseganje 5G zmogljivosti



6G Enabled Wireless Smart Society & Ecosystem

- National Flagship for **2018-2026**
- Volume **251 M€**
- Operated by **University of Oulu**
- Collaboration with **Nokia, VTT, Aalto University, BusinessOulu, OUAS.**

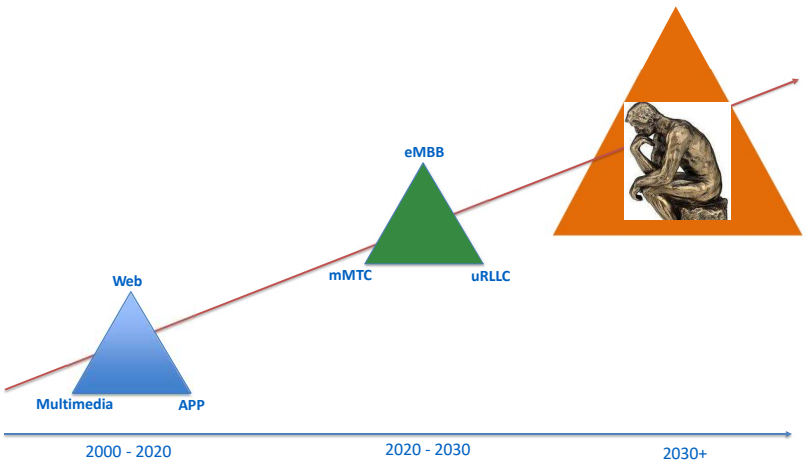
6G FLAGSHIP UNIVERSITY OF OULU

6G Flagship was elected as **Finland's high-tech Flagship**, by **Finnish Government** through **Academy of Finland**

Zaključki o 5G

- METODOLOGIJA: Najprej zahteve (KPI), sedaj iskanje ustreznih rešitev
- PODROČJE: nadgraditi obstoječe in zadovoljiti nove komunikacijske potrebe med napravami v različnih industrijskih in poslovnih procesih
- RAZVOJNI IZZIV: sodelovanje raziskovalcev, industrije, „open source“ skupnosti pri ciljnem razvoju in implementaciji novih ne preveč kompleksnih tehnologij
- POSLOVNI IZZIV: novi poslovni modeli, različne strategije „vertikal“, regulacija softveriziranega omrežja, zaupanje med deležniki
- DRUŽBENI IZZIV: vpeljava in učinkovita izraba vseh možnosti za transformacija v intenzivno informacijsko družbo

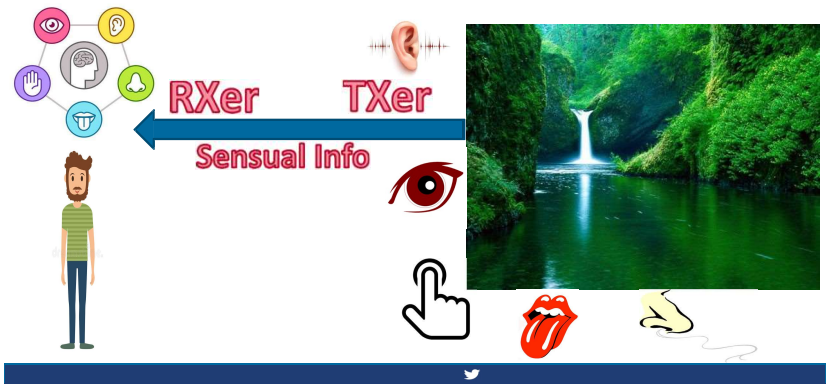
2030 and beyond: What will be?



eMBB - Enhanced mobile broadband
mMTC- Massive machine type communications
uRLLC – Ultra-reliable and low latency communications

Strokovnjaki razmišljajo „beyond 2030“
ITU-T FG NET2030

SIMPLEST FORM OF TELEPORTATION

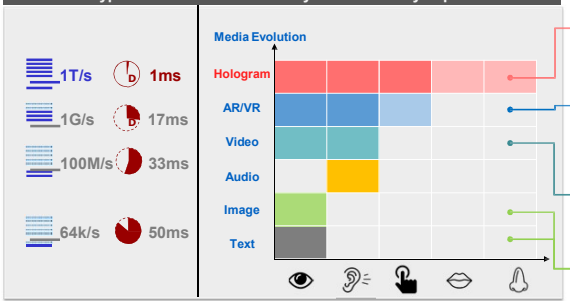


5 človeških čutov: 2 čuta že uspešno prenašamo na daljavo (vid, sluh)
tip, okus, voh so naslednji izziv…

Evolution of Media Technologies

Holographic Communication

New types of MEDIA continuously fulfill sensory experience

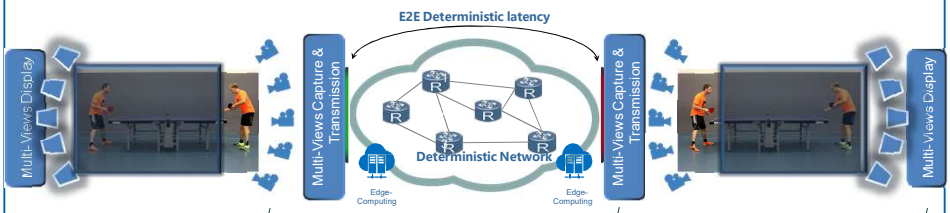


MORE Requirements for Network

- Immersive experience requires extremely high performance.
- Interoperability requires more beyond low latency
- Multi-dimension information exhaust bandwidth exponentially
- High precision Single-dimension

Holographic transmission

Holographic Communication



Ultra-high bandwidth requirement from Multi-Views capture

Deterministic latency requirement from interactions

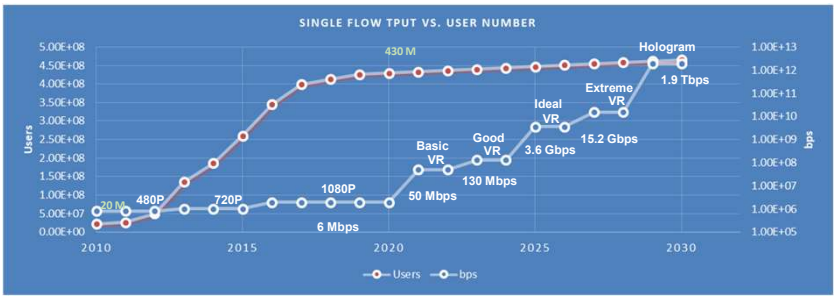
High-sync and loss tolerant features require new transport technologies

Parameters	Resolution	Dot Pitch	Display Size	Bits per Pixel	Static Compression	Motion Compression	Static Image Size	Motion Image Size (at 60FPS)
Hologram (5.9inch)	124,800*70,200	1um	12.48cm*7.02cm	24bits/pixel	40:1	1000:1	5.25Gbits	12.6Gbps
Hologram (70inch)	1,536,000*864,000	1um	153.6cm*86.4cm	24bits/pixel	40:1	1000:1	796Gbits	1.9Tbps

Fakulteta za elektrotehniko, Univerza v Ljubljani

Future applications traffic patterns

EBS: Network 2030, Lisbon



Here we see the traffic patterns given the growing number of users (*red dots*) and the throughput of a single flow (*blue dots*), for the future applications.

We can see the massive increase in flow sizes for the application types.

2010 - 2020

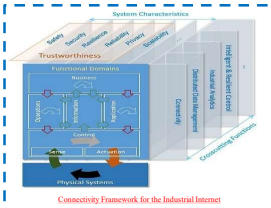
User increased **21x** from 20M to 430M.

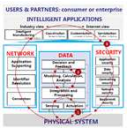
2020 - 2030

User increased **3%**YoY
Flow tput to increase **2500X** (1080p vs. Extreme VR)

Verticals: Deterministic Latency, Cooperative Synchronization, Flexible Extension, Diverse Use

IIoT





All. IIoT White Paper 2018

Key Network Metrics for Industrial Internet:
- Extremely low latency: *ms* level (with *us* level jittering)
- Ultra-high reliability: *>99.999%*
- Precise synchronization
- Super-massive connections
- Energy efficiency
- Ultra-high bandwidth for particular applications

Industrial fieldbus is merged with outside network to form Industry Internet, which needs large-scale synchronization with deterministic data transmission.

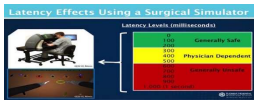
Tele-Medical Operations

Direct tele-medical service (2001~2020)

MiroSurge system developed at DLR with table-mounted manipulators.

Synchronization via human + machine (~2025)

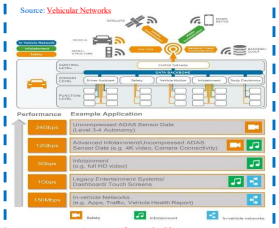
Two surgeons in remote synchronization via **Raven II**



Tele-medical services are emerging with requirements of high-precision coordination, and low latency signaling.

Vehicular Networks

Source: Vehicular Networks

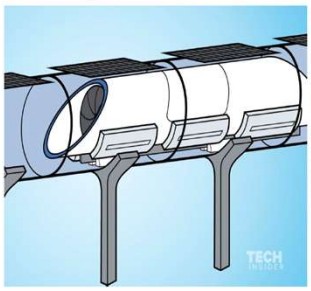


Vehicle-to-X networks enables new communications (X=human/vehicle/road-side/cloud/etc); and in-vehicle data is expected to be boosted dramatically; safety requires ultra-low latency and wide-scale synchronization.

[1] https://www.atlantajewelryshow.com/road-ahead-2019/
[2] http://pro-bind.com/verticalmarkets.php
[3] https://www.sirris.be/blog/first-connectivity-framework-industrial-internet

Hyperloop (CEN/CENELEC started standardization!)

3. Description



ETT/Hyperloop is defined as:

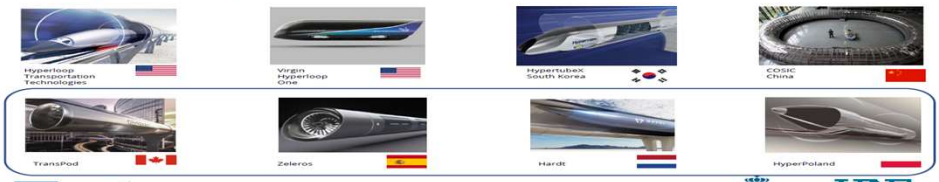
a ground-based [1], high-speed [2] transportation system for passengers, living and/or non-living stock [3].

The vehicles — for the majority [4] of any journey [5] — are suspended through contactless [6] means and travel inside a sealed, confined and reduced-pressure [7] environment.

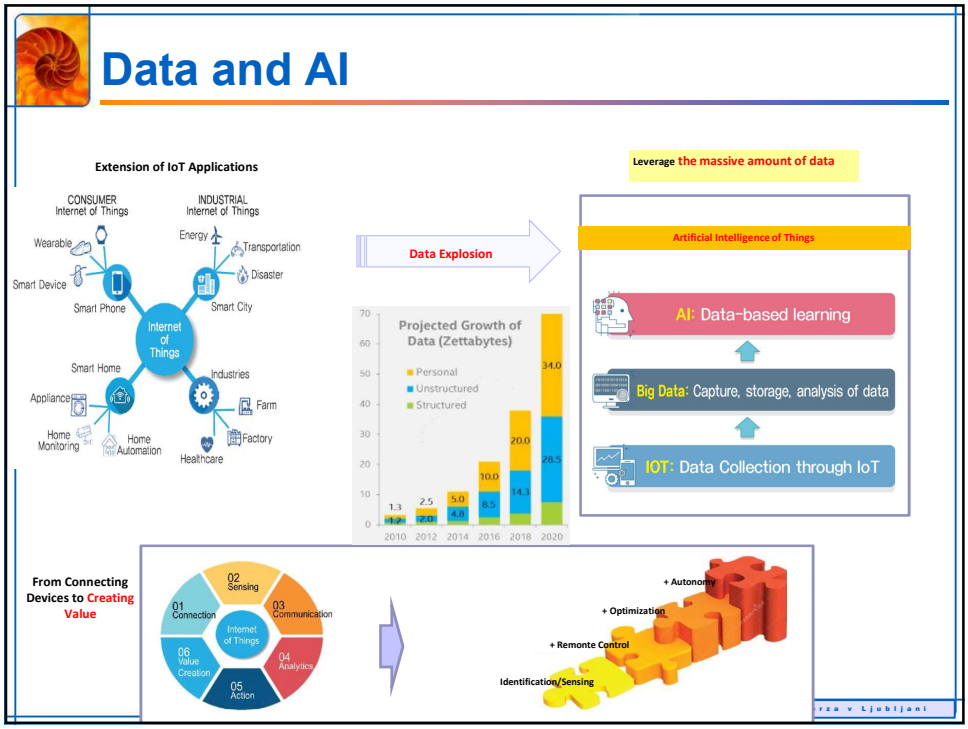
NEN UNE

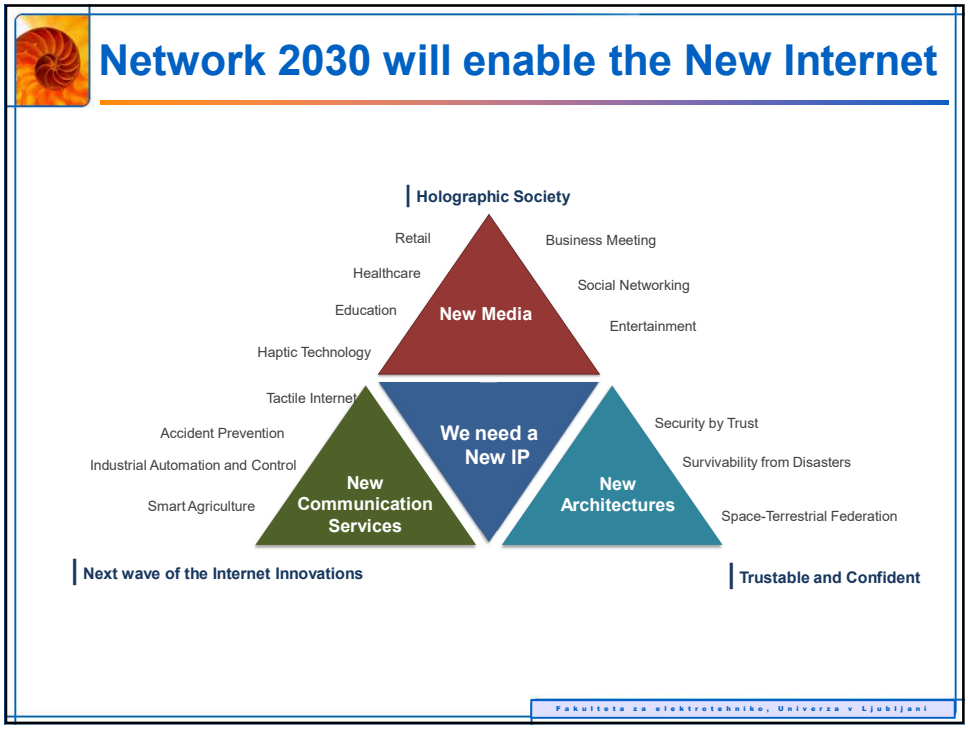
The global network

Hyperloop promoters

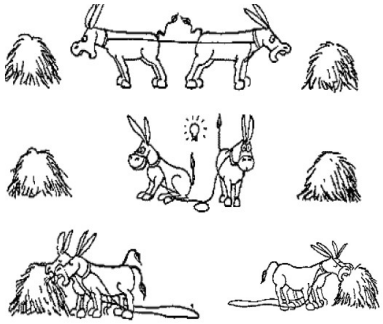


CEN CENELEC NEN UNE


Data and AI
Extension of IoT Applications
CONSUMER Internet of Things
INDUSTRIAL Internet of Things
Wearable
Energy
Transportation
Smart Device
Disaster
Smart Phone
Smart City
Internet of Things
Smart Home
Industries
Appliance
Farm
Home Monitoring
Home Automation
Factory
Healthcare
Data Explosion
Projected Growth of Data (Zettabytes)
Personal
Unstructured
Structured
Leverage the massive amount of data
Artificial Intelligence of Things
AI: Data-based learning
Big Data: Capture, storage, analysis of data
IOT: Data Collection through IoT
From Connecting Devices to Creating Value
01 Connection
02 Sensing
03 Communication
04 Analytics
05 Action
06 Value Creation
+ Autonomy
+ Optimization
+ Remonte Control
Identification/Sensing


Network 2030 will enable the New Internet
Holographic Society
Retail
Business Meeting
Healthcare
Social Networking
Education
New Media
Entertainment
Haptic Technology
Tactile Internet
Accident Prevention
We need a New IP
Security by Trust
Industrial Automation and Control
Survivability from Disasters
Smart Agriculture
New Communication Services
New Architectures
Space-Terrestrial Federation
Next wave of the Internet Innovations
Trustable and Confident

- **Ali imamo v SLOVENIJI VOLJO, ZNANJE IN RESURSE za sodelovanje v procesu OBLIKOVANJA novih omrežij?**
- **KDAJ bomo doma implementirali nove doktrine?**



Najava SIST ISO TC268 aktivnosti (EU predsedovanje 2021)

The Purpose of Society 5.0

Economic advancement	Resolution of social problems
• The demand for energy is increasing • The demand for foodstuffs is increasing • Lifespan is becoming longer, and the aging society is advancing • International competition is becoming increasingly severe • Concentration of wealth and regional inequality are growing	• Reduction of GHG emissions • Increased production and reduced loss of foodstuffs • Mitigation of costs associated with the aging society • Promotion of sustainable industrialization • redistribution of wealth, and correction of regional inequality

Incorporating new technologies such as IoT, robotics, AI, and big data in all industries and social activities, provide goods and services that granularly address manifold latent needs without disparity

to balance economic advancement with the resolution of social problems

Source: Cabinet Office Japan

Standardization of Society 5.0

Concept proposal team

We need collaboration of Slovenia Institute of Standardization in ISO

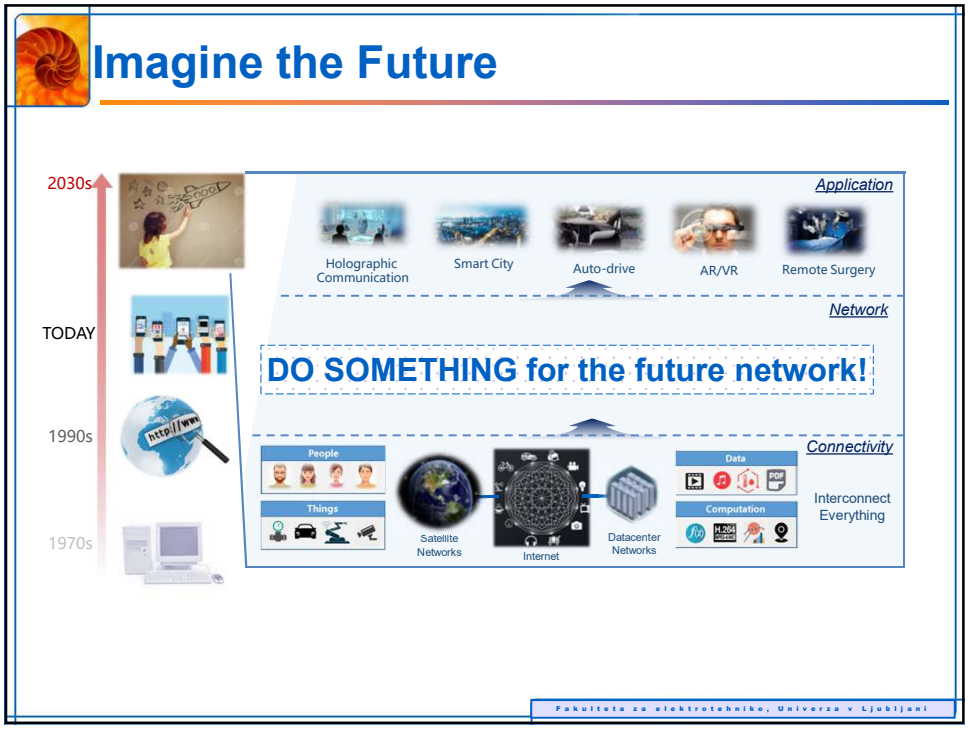
Tentative title:
Sustainable Society Enabled by Cyber Physical Systems

ISO

Generic High-level Standard

Specific Business Level Standard

How to Implement in Slovenia


Imagine the Future
2030s
TODAY
1990s
1970s
Application
Holographic Communication
Smart City
Auto-drive
AR/VR
Remote Surgery
Network
DO SOMETHING for the future network!
Connectivity
People
Things
Satellite Networks
Internet
Datacenter Networks
Data
Computation
Interconnect Everything
Fakulteta za elektrotehniko, Univerza v Ljubljani


HVALA ZA POZORNOST
alojz.hudobivnik@gmail.com
20-4-2020 102/102
Fakulteta za elektrotehniko, Univerza v Ljubljani