ITU-T
STUDY GROUP 15

Networks, Technologies and Infrastructures for Transport, Access and Home

Summary of Results
Study Period 2013-2016

Dr. Stephen J. Trowbridge

1956 2016
CCITT / ITU-T

Terms of Reference

SG15 is responsible for the development of **standards** on:

- optical transport network
- systems
- instrumentation and measurement techniques
- access network
- equipment
- maintenance
- management
- test
- home network and power utility network infrastructures
- optical fibres and cables and their related installation
- control plane technologies

to enable the evolution toward intelligent transport networks, including the support of smart-grid applications.

Lead Study Group Activities

Access Network Transport

Optical Technology

~~Optical Transport Networks~~ (redundant)

Smart Grid

Home Networking (new for 2017-2020 period)

Achievements

WP1 – Broadband Access

G.9802 Generic multi-wavelength PON (G.multi)

40G fiber access (NG-PON2 - G.989)

Symmerical 10G PON (G.9807)

G.9801 Ethernet-based PON (EPON)

G.fast up to 1 Gbps access

VDSL2 vectoring for 100 Mbps; 300 Mbps VDSL2 with 35b profile

Narrowband PLC for smart grid

G.hn home networking up to 1 Gbps

G.9977 mitigation of interference between DSL and G.hn

Collaboration with BBF

WP2 – Optical Technologies

Single-mode fibre (G.652, G.654, G.657)

Short-reach (client) 40G and 100G OTN interfaces

Multichannel bi-directional DWDM applications (G.metro)

Multi-vendor interoperable coherent modulation for 100G (G.698.2)

Submarine cable systems including coherent 100 Gbit/s applications (G.97x series)

Optical components: optical amplifier, optical splitters and multi-degree-ROADM

Disaster management for survivable networks (L.392)

WP3 – Optical Transport Networks

Network resilience for OTN, Ethernet and MPLS-TP

Equipment & management for OTN, Ethernet and MPLS-TP

OTN hierarchy and Interfaces (G.709) for beyond 100G bit/s signals (n x 100 Gbit/s) including mobile fronthaul/backhaul, etc.

Major update of OTN Architecture (G.872)

Network synchronization and time distribution (G.82xx series)

Architecture of transport networks (G.800) and transport SDN (G.7701)

Core information model for Software-Defined Networking (SDN) architectures (G.7711/Y.1702)

Future Work

WP1 – Future Work

G.FAST

Next generation G.fast >2 Gbps

Visible Light Communication for home networking

DTA

G.fast dynamic time assignment (DTA) – downstream/upstream bit-rates responsive to customer traffic

Powerline communication (PLC)

Continue collaboration with broadband forum

Next generation of converged fiber access going to higher speeds

G.Hn

G.hn home networking over indoor phone, power, and coax wires >2 Gbps

WP2 – Future Work

Easy and environmentally friendly outside plants

Disaster Management issues

100G and future higher-rate coherent multi-vendor interoperable interfaces

Multichannel bi-directional DWDM applications targeted at lower cost optical solutions for applications including mobile fronthaul and backhaul

200G
400G

Short-reach (OTN client) 200G and 400G interfaces reusing components developed for Ethernet applications

WP3 – Future Work

Transport and synchronization supporting 5G mobile fronthaul and backhaul

Optical Transport Networks

Synchronization of packet networks and future OTN networks, e.g., beyond 100G

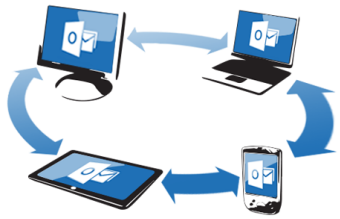
Architecture and other Transport SDN Aspects

Network survivability (protection and restoration)

New “B100G” OTN interfaces, including the use of coherent G.698.2 interfaces under development

Management aspects of control and transport planes

Equipment & management specifications for OTN, Ethernet and MPLS-TP



Core Information model enhancement for management of synchronization and optical media

Conclusions

✓ Leading development of

Optical Transport Networks

Smart Grid

ACCESS NETWORK

Home Networking

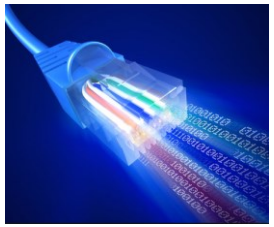
✓ The **LARGEST** and **MOST PRODUCTIVE** group in ITU-T with broad, global industry participation

✓ Highlights include:

Home Networking

Smart Grid

High Speed Access



Transport Technologies

The Optical Transport Network

Additional Slides

Terms of Reference

- Responsible for the development of standards on optical transport network, access network, home network and power utility network infrastructures, systems, equipment, optical fibres and cables, and their related installation, maintenance, management, test, instrumentation and measurement techniques, and control plane technologies to enable the evolution toward intelligent transport networks, including the support of smart-grid applications.

Lead Study Group Activities

- Access Network Transport
- Optical Technology
- ~~Optical Transport Networks~~ (redundant)
- Smart Grid
- *Home Networking (new for 2017-2020 period)*

Highlights of achievements (WP1)

- XG-PON Symmetrical 10 Gbps fiber access (G.9807)
- NG-PON2 40 Gbps fiber access (G.989)
- G.9801 Ethernet-based PON (EPON)
- G.9802 Generic multi-wavelength PON (G.multi)
- VDSL2 vectoring cancels crosstalk to raise bit-rates up to 100 Mbps; VDSL2 bit-rates rise to 300 Mbps with 35b profile
- G.fast up to 1 Gbps access over phone and coax wires from FTTdp node
- Collaboration with BBF on YANG management models for DSL and G.fast equipment
- G.hn home networking over indoor cables (phone, power, coax, and fiber) up to 1 Gbps, including MIMO for enhanced performance
- G.9977 mitigation of interference between DSL and G.hn – ITU facilitated cooperation between different industry sectors
- Powerline communication(PLC) – narrowband for a smart grid, G3, PRIME, G.hnem

Highlights of achievements (WP2)

- Revision of single-mode fibre Recommendations (G.652, G.654, G.657)
- Short-reach (client) 40G and 100G OTN interfaces reusing components developed for Ethernet applications
- Progress on Multichannel bi-directional DWDM applications with port agnostic single-channel optical interfaces (G.metro)
- Progress on multi-vendor interoperable coherent modulation formats for 100G applications (G.698.2)
- Optical components and subsystems such as optical amplifier devices, optical splitters and multi-degree-ROADM
- Optical fibre submarine cable systems including coherent 100 Gbit/s applications (G.97x series)
- Disaster management for improving network resilience and recovery with movable and deployable ICT resource units (L.392)

Highlights of achievements (WP3)

- OTN hierarchy and Interfaces (G.709) for beyond 100G bit/s signals (n x 100 Gbit/s), including client mappings supporting OTN application including telco, mobile fronthaul/backhaul, data center interconnect, and video distribution
- Major update of OTN Architecture (G.872)
- Continuous updates to equipment & management specifications for OTN, Ethernet and MPLS-TP
- Architecture of transport networks and architecture of transport SDN
- Network synchronization and time distribution (G.82xx series), including new telecom grandmaster clocks and an enhanced primary reference time clock
- Core information model for transport resources for transition to Software-Defined Networking (SDN) architectures (G.7711/Y.1702)
- Architecture of transport networks (G.800) and architecture of transport SDN (G.7701)
- Network restoration and protection for OTN, Ethernet and MPLS-TP

Future Work (I)

- Next generation of converged fiber access going to higher speeds
- Next generation G.fast >2 Gbps using telephone and coax wires
- G.fast dynamic time assignment (DTA) – downstream/upstream bit-rates responsive to customer traffic
- Continue collaboration with BBF on YANG management models for DSL equipment, expanding to include fiber access systems
- G.hn home networking over indoor phone, power, and coax wires >2 Gbps
- Visible Light Communication for home networking
- Continue evolution of Powerline communication (PLC)

Future Work (II)

- Easy and environmentally friendly installation technology for outside plant
- Progress on Disaster Management issues
- Continued work on 100G and future higher-rate coherent multi-vendor interoperable interface specifications
- Short-reach (OTN client) 200G and 400G interfaces reusing components developed for Ethernet applications
- Continue work on Multichannel bi-directional DWDM applications with port agnostic single-channel optical interfaces targeted at lower cost optical solutions for applications including mobile fronthaul and backhaul

Future Work (III)

- Transport and synchronization supporting 5G mobile fronthaul and backhaul
- Architecture and other Transport SDN Aspects
- Synchronization of packet networks and future OTN networks, e.g., beyond 100G
- New "Beyond 100G" OTN interfaces, including frame formats for reuse of Ethernet 200G and 400G components for OTN client interfaces and use of coherent G.698.2 interfaces under development
- Network survivability(protection and restoration)
- Continuous updates to equipment & management specifications for OTN, Ethernet and MPLS-TP
- Management aspects of control and transport planes
- Core Information model enhancement for management of synchronization and optical media

Conclusion

- Leading development of **optical transport network**, **access network**, **home networking**, and **smart grid** standards in ITU.
- The **largest** study and **most productive** group in ITU-T, with broad, global industry participation
- Highlights include home networking, smart grid, high speed access, optical transport network infrastructure and transport technologies.

- Management team
- Structure
- Statistics

Management Team – 2/2

WP1/15 Chairman	*Tom STARR*	*(USA)*
WP1/15 Vice-Chairman	*Hubert MARIOTTE*	*(FRANCE)*
WP2/15 Chairman	*Francesco MONTALTI*	*(Italy)*
WP2/15 Vice-Chairman	*Viktor KATOK*	*(Ukraine)*
WP3/15 Chairman	*Ghani ABBAS*	*(UK)*
WP3/15 Vice-Chairman	*Malcolm BETTS*	*(China)*

Meetings

- Meetings of 2013-2016 Study Period
  - SG15 meetings
    - Geneva, 1-12 July 2013
    - Geneva, 24 March – 4 April 2014
    - Geneva, 24 November – 5 December 2014
    - Geneva, 22 June – 3 July 2015
    - Geneva, 15 – 26 February 2016
    - Geneva, 19-30 September 2016
  - WP1/15 meetings
    - Geneva, 1 February 2013
    - Geneva, 6 December 2013
  - 102 face-to-face Rapporteur Group meetings authorized

- First SG15 meeting of 2017-2020 study period
  - Geneva, 19 – 30 June 2017 (provisional)

Study Group Structure

- WP 1: Transport aspects of access, home and smart grid networks
  - Access network standards. (PON and xDSL)
  - Home networking
  - Smart Grid
- WP 2: Optical technologies and physical infrastructures
  - Optical fibres and cables
  - Optical components
  - Optical interfaces
- WP 3: Transport network characteristics
  - Transport networks based on OTN, Ethernet, MPLS-TP with applications including telco, mobile fronthaul/backhaul, data center interconnect
  - Timing and synchronization
  - Management and control, including application of SDN to transport

Questions under SG15

- Q1:Coordination of access and Home Network Transport standards
- Q2: Optical systems for fibre access networks
- Q3: General characteristics of transport networks
- Q4: Broadband access over metallic conductors
- Q5: Characteristics and test methods of optical fibres and cables
- Q6: Characteristics of optical systems for terrestrial transport networks
- Q7: Characteristics of optical components and subsystems
- Q8: Characteristics of optical fibre submarine cable systems
- Q9: Transport network protection/restoration
- Q10: Interfaces, Interworking, OAM and Equipment specifications for Packet based Transport Networks
- Q11: Signal structures, interfaces, equipment functions, and interworking for transport networks
- Q12: Transport network architectures
- Q13: Network synchronization and time distribution performance
- Q14: Management and control of transport systems and equipment
- Q15: Communications for Smart Grid
- Q16: Outside plant and related indoor installation
- Q17: Maintenance and operation of optical fibre cable networks
- Q18: Broadband in-premises networking

Statistics (I)

- 2163 contributions received
- 2811 TDs generated
- 403 Liaison Statements generated
- 6 SG meetings held
- 2 separate WP1/15 meetings held
- 102 face-to-face Rapporteur Group meetings authorized
- Average 290 participants per SG meeting

Statistics (II)

- 7 Texts Determined
- 275 Texts Consented
- 19 Texts Agreed
- 39 New Recommendations
- 253 Revised Recommendations, Amendments, Corrigenda
- 12 Supplements
- 18 Questions assigned by WTSA-12
- 18 Questions proposed for next period

Thank you!

Dr. Stephen J. Trowbridge is a Consulting Member of Technical Staff (CMTS) at Nokia and a member of the standards team for the IP and Optical Networking (ION) business group. He received his B.S. (EE&CS), M.S. (CS), and Ph.D. (CS) from the University of Colorado, Boulder. He joined Bell Laboratories–AT&T (now Nokia) in 1977. He has been active in optical networking standardization since 1995. He is chairman of ITU-T Study Group15, Networks, Technologies and Infrastructures for Transport, Access and Home. He was a member of the IEEE P802.3ba 100 Gb/s Ethernet editorial team and is currently a member of the IEEE P802.3bs 200 Gb/s and 400 Gb/s Ethernet editorial team. He is editor of the Optical Internetworking Forum (OIF) Flex Ethernet implementation agreement. He was named a Bell Labs Fellow in 2014.