The IEEE 802.1 Standards

Tony Jeffree, Consultant
tony@jeffree.co.uk

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IEEE-SA Standards Board Operation Manual (subclause 5.9.3)

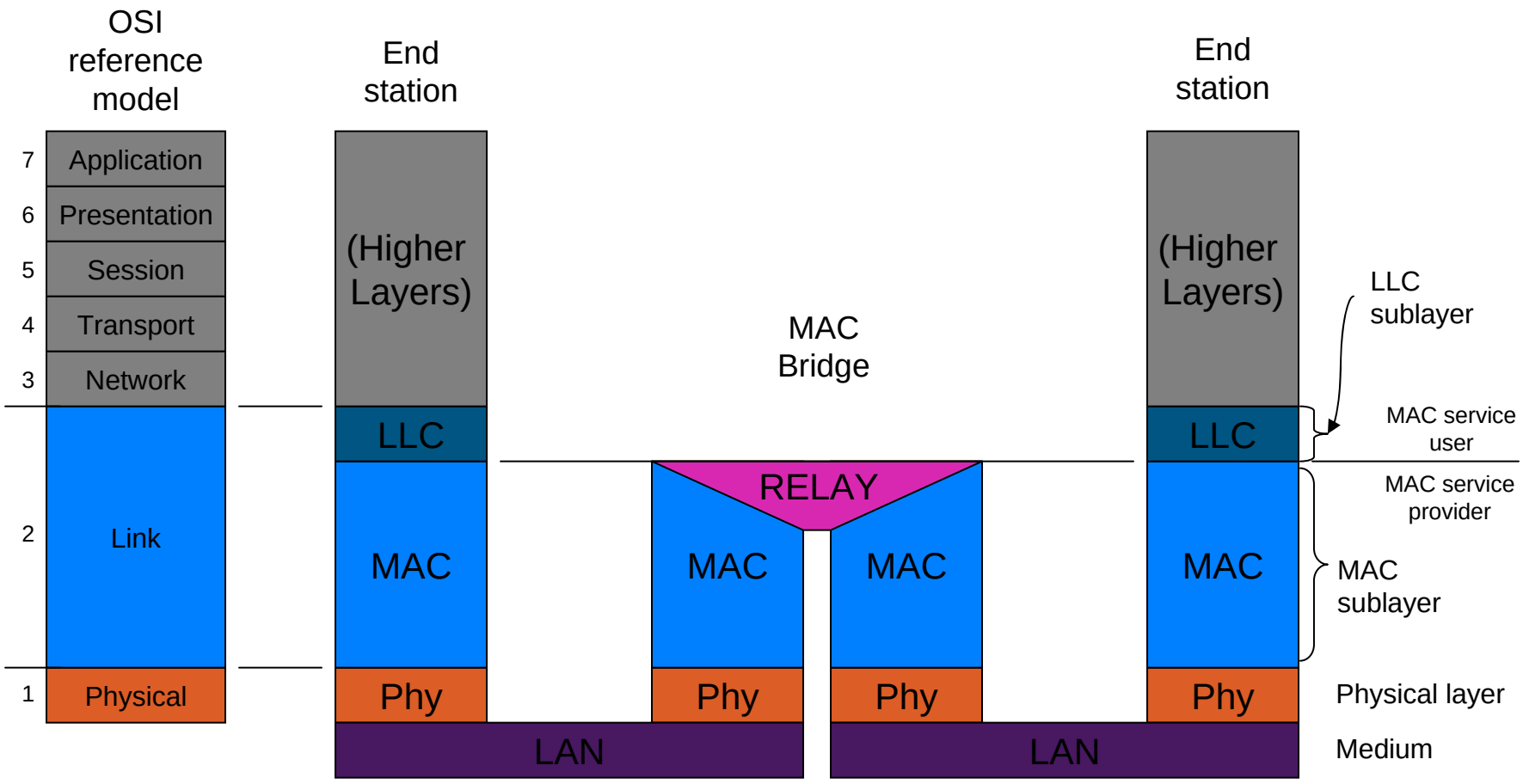
MENU

- What is 802.1?
- The Bridging standards
  - “Traditional” Bridging
  - Audio Video Bridging (AVB)
  - Data Center Bridging (DCB)
- The Security standards
- Where to find out more

What is 802.1?

- Keeper of the LAN architecture – IEEE Std 802
  - Describes the 802 family of standards
  - Describes the LAN architecture
  - Defines some useful things, such as the LAN address format, the SNAP protocol, the “Playpen Ethertypes”, and the OID registration arcs
- The “Higher Layer Interface” working group in 802
  - Defines the Bridging and security “glue” that interconnects the LANs defined by the 802 MAC groups

The 802 LAN Architecture



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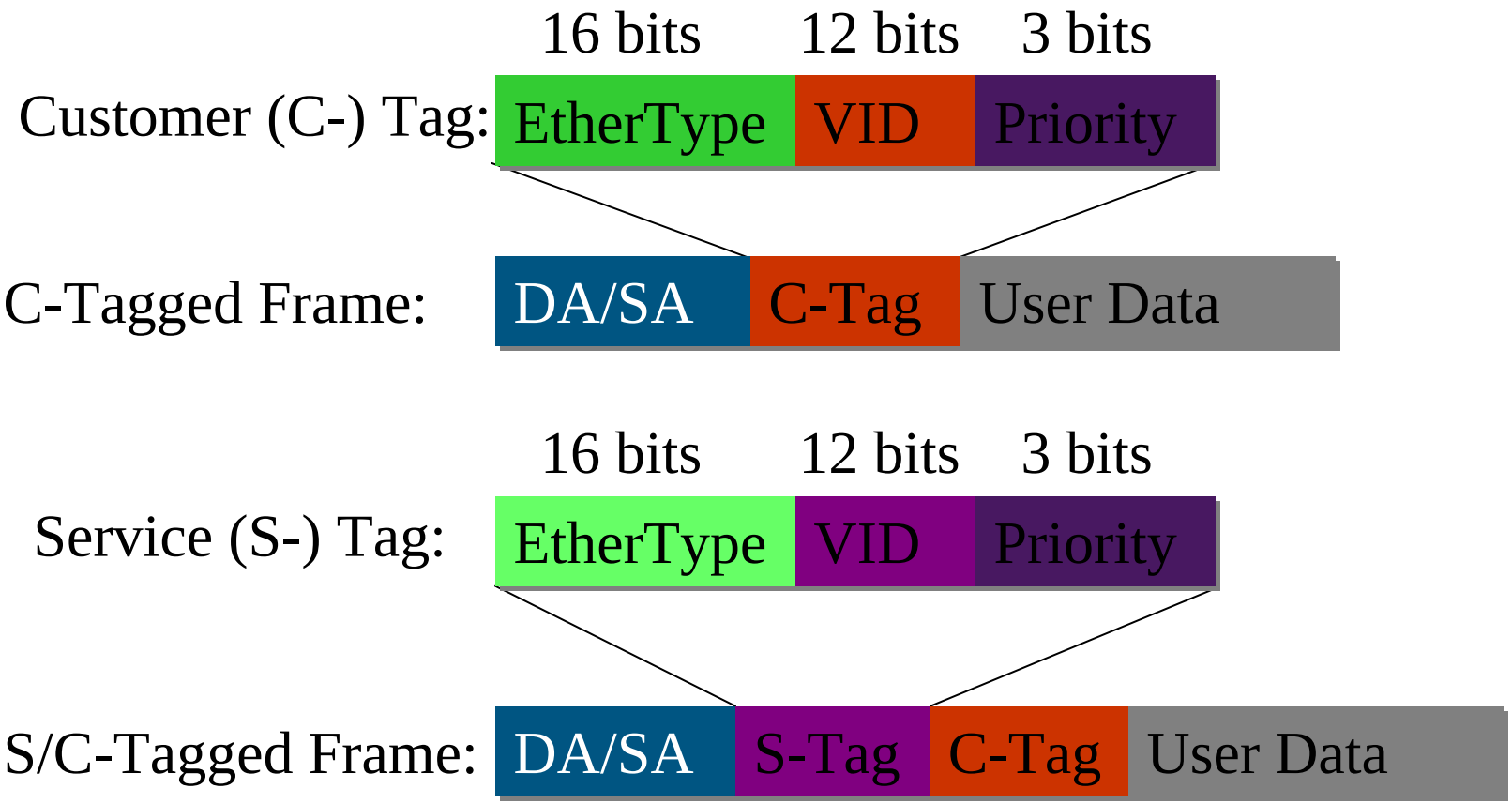
802.1Bridging standards - 1: The core Bridging standards

- Two base standards: 802.1D:2004 (MAC Bridging) and 802.1Q:2005 (VLAN Bridging), but 802.1D will be subsumed into 802.1Q in its next revision
- Support for LAN reconfigurations in 50ms or less ("Rapid Spanning Tree")
  - Cures the historical problem of slow reconfiguration times
  - Makes Bridged Ethernet competitive as a means of offering metro services
- Support for up to 4094 VLANs over a single Spanning Tree (SST) or over multiple (up to 64) Spanning Tree instances (MST)
  - Provides options for load balancing
  - Allows choice of how VLANs map to Spanning Trees

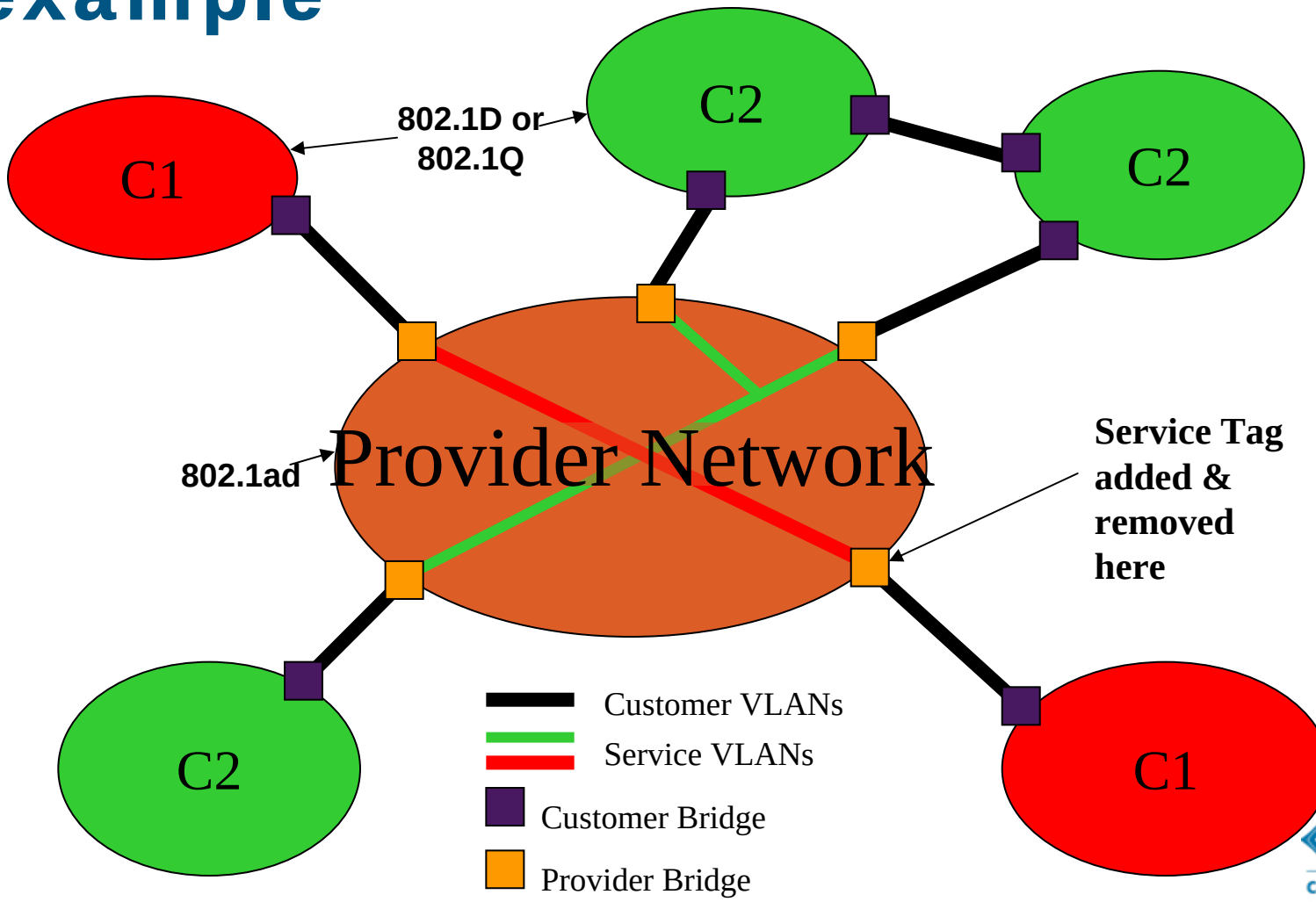
802.1Bridging standards – 2: Provider Bridging

- 802.1ad:2005 Provider Bridging - supports metro-area “provider” bridged LANs that can (trivially) multiplex 4094 X 4094 distinct services
- 802.1ah:2008 Provider Backbone Bridging
  - Adds a 24-bit I-SID giving ~16 million “service instance identifiers”
  - Adds a tunnelling protocol (external MAC addresses are local to the backbone)

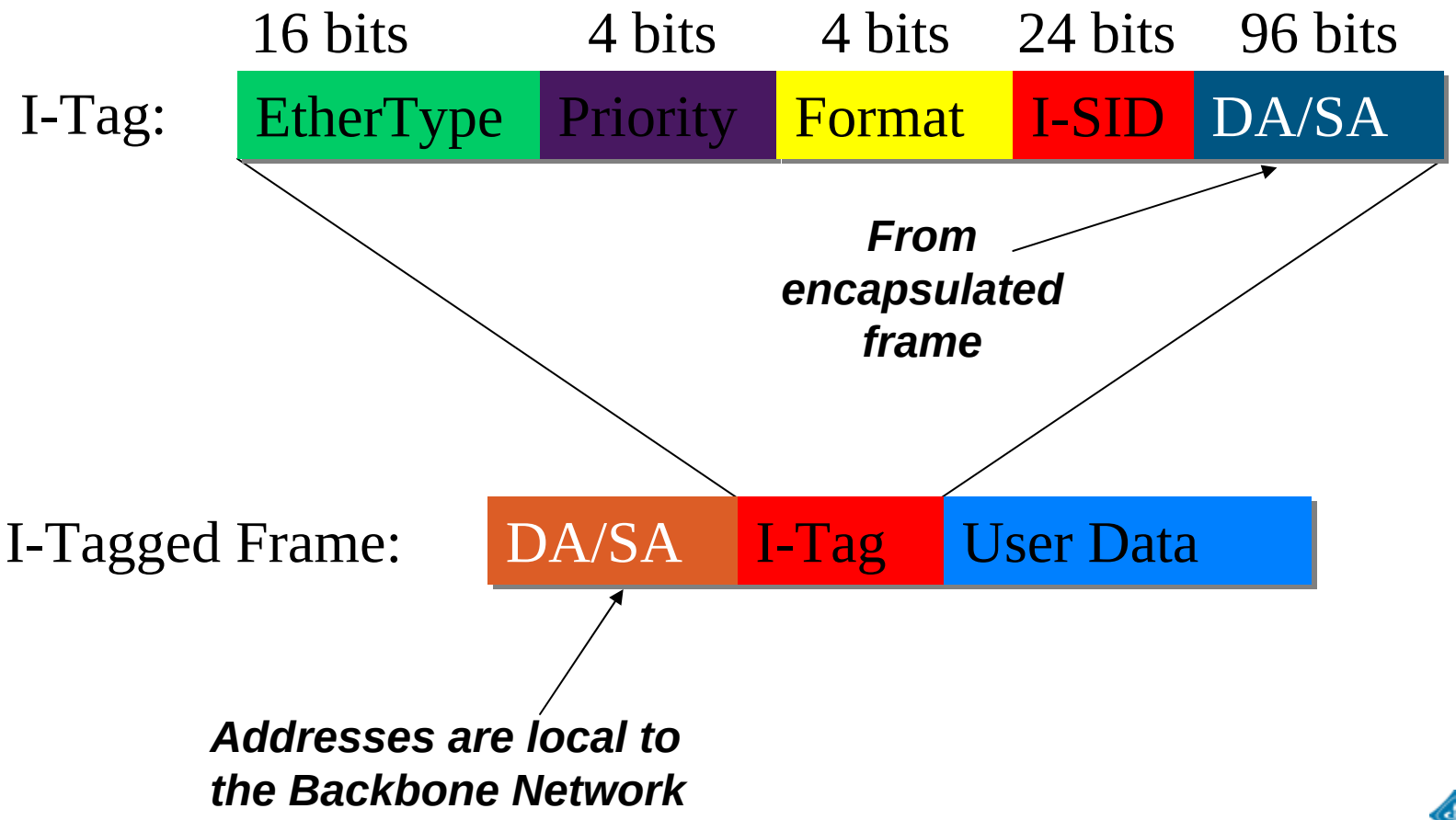
“C” and “S” tags in 802.1Q



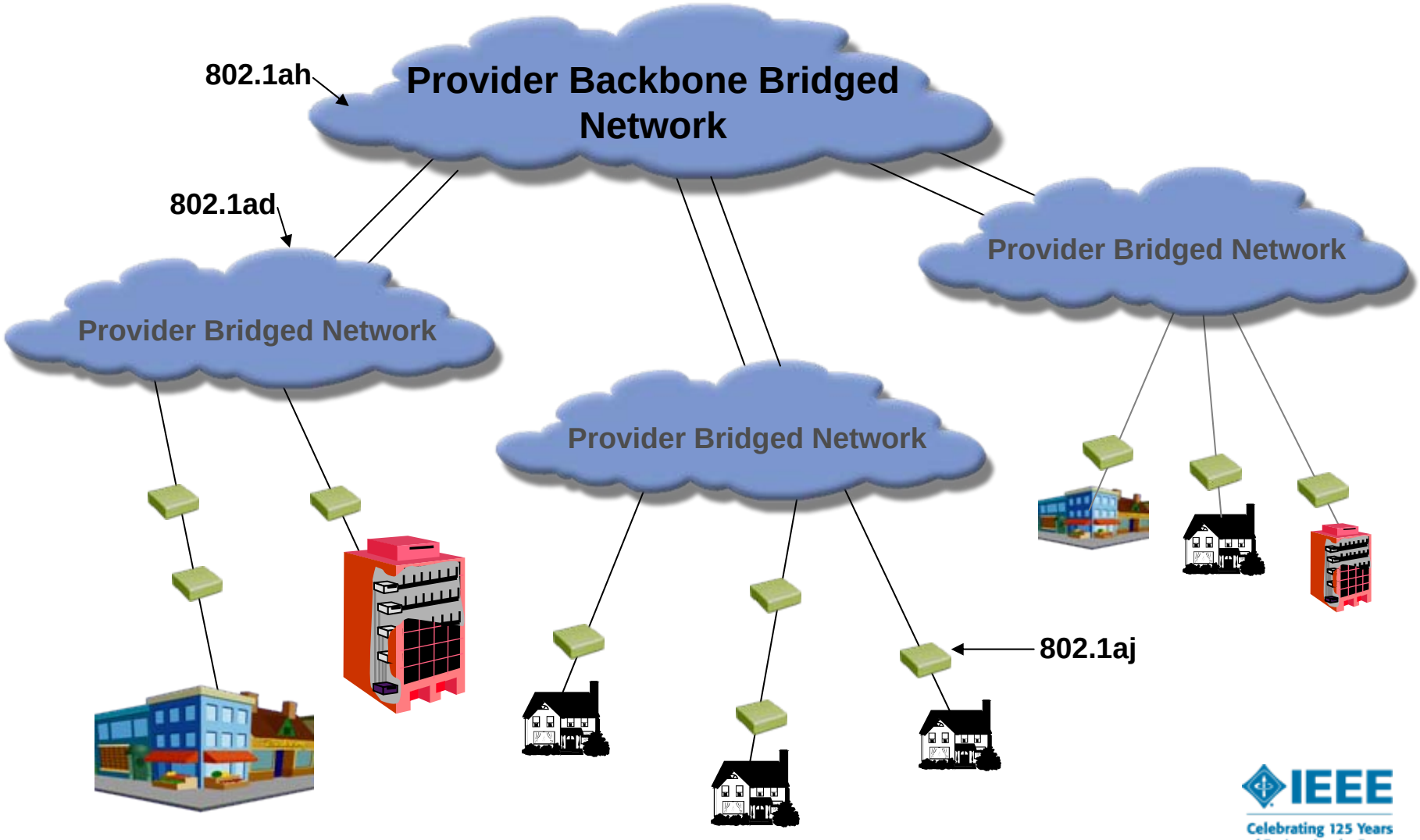
Simple provider network example



Service Instance tags (I-Tags) in 802.1ah



Provider Backbone Bridged LAN



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802.1Bridging standards – 3: Provider Bridging – Traffic Engineering (TE)

- 802.1aw:2009 Provider Backbone Bridge Traffic Engineering – supports the construction of “traffic engineered” backbone topologies, protection switching, etc. to serve the needs of large service providers.

802.1Bridging standards – 4: Management

- 802.1ag:2007 Connectivity Fault Management and 802.1Qaw:2009 Management of Data Driven and Data Dependent Connectivity Faults
  - Fault-finding tools (continuity checks, loopback functions etc.) aimed at managing both service provider and service user networks
- 802.1ap:2008 MIB definitions for VLAN Bridges – defines the set of MIBs required in order to support SNMP-style management of all of the Bridging technologies covered by 802.1Q and 802.1D
  - Configuration and statistics gathering tools

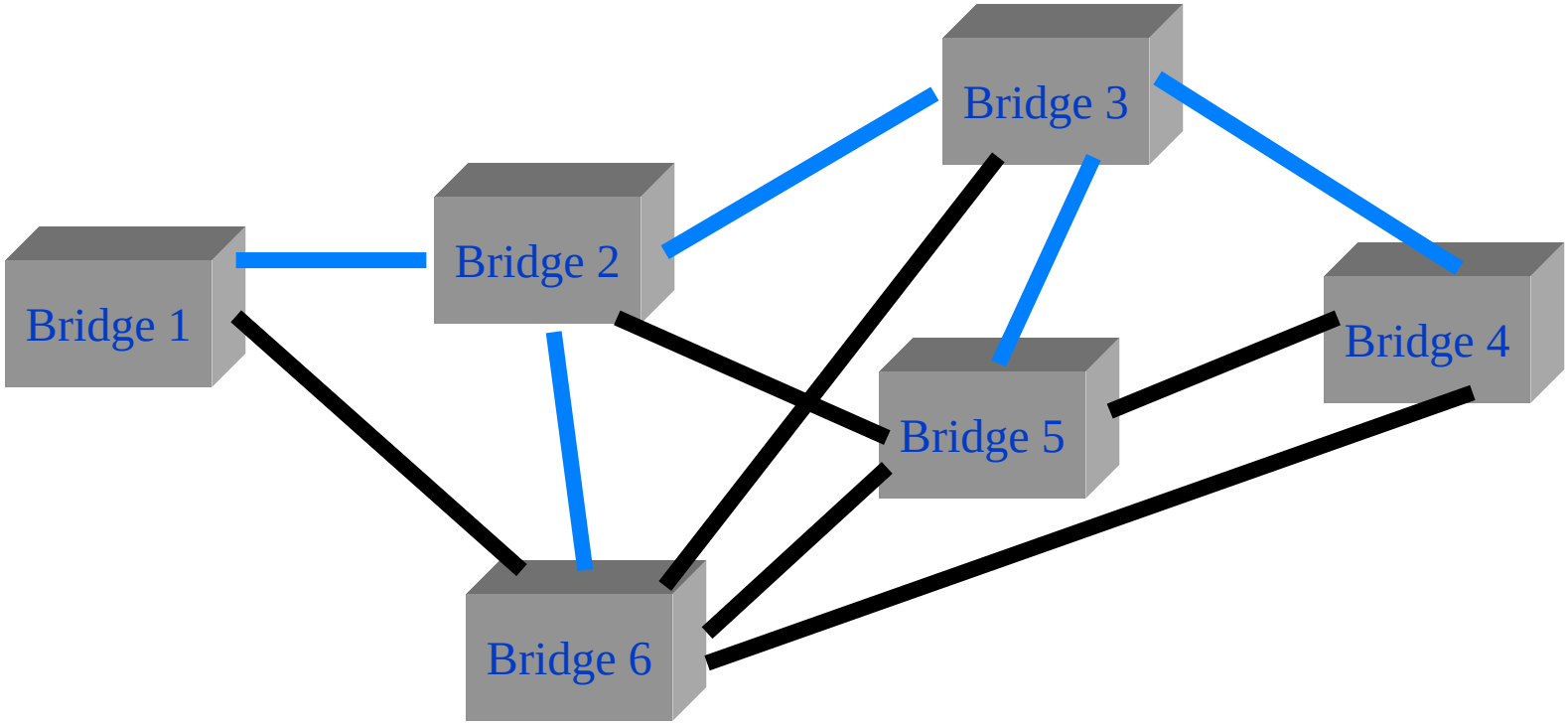
Ongoing developments

- P802.1aj Two-port MAC Relay
  - Simple 2-Port Bridge – no Spanning Tree support
  - Acts as a “demarc” device between service provider and service user
  - Can be used to translate between “true” Ethernet and emulated Ethernet services
- P802.1aq Shortest Path Bridging
  - Intent is to provide optimal use of the available bandwidth in the network
  - Has caused a move away from distance-vector routing techniques to some variant of link state

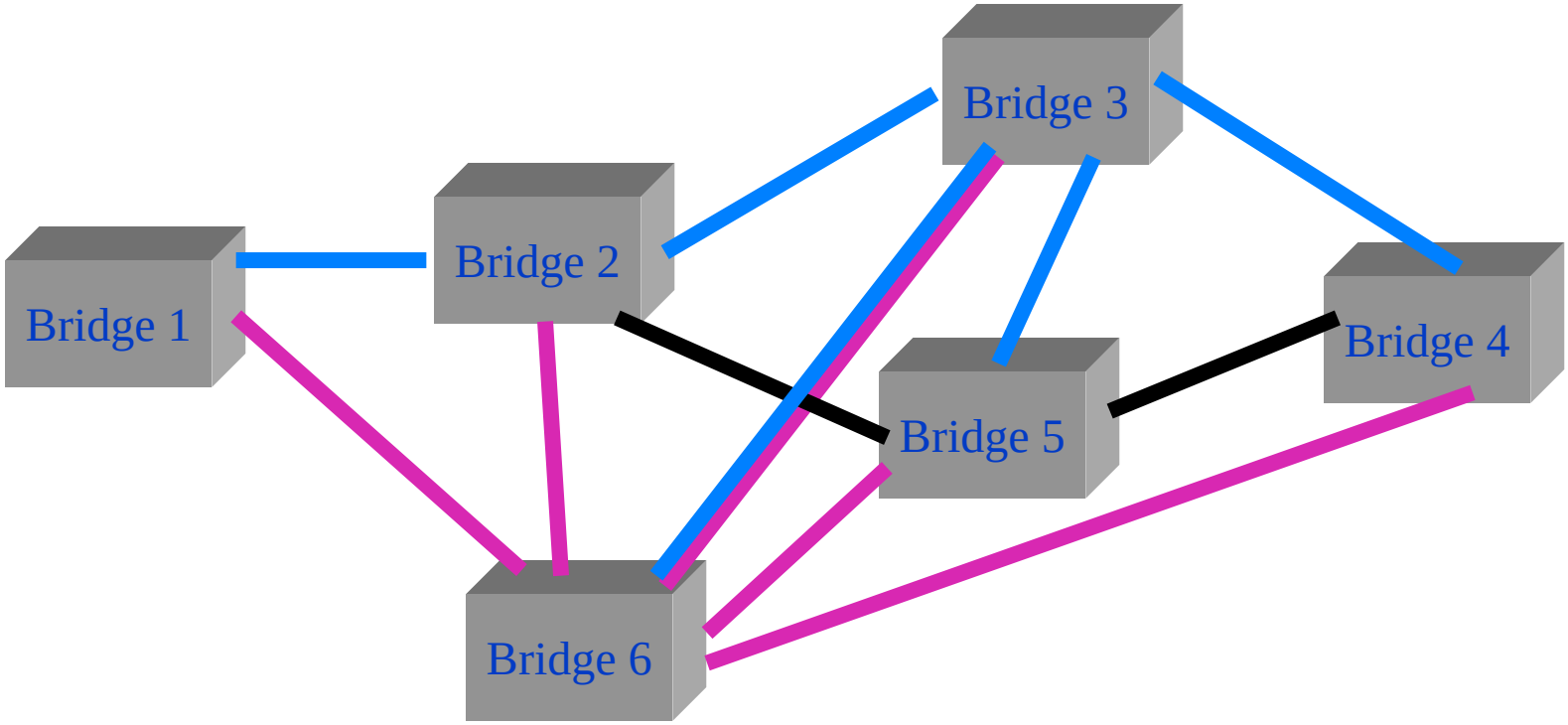
Why Shortest Path Bridging?

- Rapid Spanning Tree confines traffic to a single Spanning Tree
  - Unused LANs, therefore wasted bandwidth
- Multiple Spanning Trees splits traffic across Spanning Trees by VLAN
  - Better utilisation of bandwidth but still can be sub-optimal paths
- Shortest Path Bridging allows connectivity trees to be created per source Bridge
  - A tree rooted at a Bridge defines the shortest path from that Bridge to any other Bridge

A Spanning Tree isn't necessarily a Shortest Path



Shortest Path Trees



Inactive LAN segment

Active LAN segment for tree rooted at Bridge 3

Active LAN segment for tree rooted at Bridge 6

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AVB: Bridging tackles home entertainment…

- Audio-visual applications in home and studio environments generate a particular set of QoS requirements
  - The need to synchronize audio/video in several adjacent rooms/areas
  - The need to prioritize AV traffic to ensure that it stays within latency/jitter bounds
  - The need to minimize packet loss
- Potentially an enormous market
  - Home AV applications
  - Studio/concert hall applications
  - Large venues e.g., theme parks
- Four standards currently under development:
  - 802.1AS – Time synchronization
  - 802.1Qat – Stream reservation protocol
  - 802.1Qav – Forwarding and queuing for time sensitive streams
  - 802.1BA – AVB Systems

P802.1AS – Time Synchronization

- A common notion of time is needed in order for distributed AV applications to synchronize
  - Lip synch between audio and video streams
  - Synch between different instruments in a band
  - Synch between speakers in adjacent rooms playing the same music
  - …etc.
- AS protocol accurately measures the delay between adjacent network nodes, and distributes a common “master” time from an accurate clock
- Resilient in the face of network reconfiguration
- Based on IEEE Std 1588 with extensions to meet the particular needs of LANs

P802.1Qat – Stream Reservation Protocol (SRP)

- Provides a means of reserving bandwidth for streams
- Ensures that the path from the stream originator (Talker) to the stream destinations (Listeners) is not oversubscribed
- Ensures that a Talker does not start to use network resources for a stream until those resources have been allocated to the stream
- Deals with re-assignment of resources on network reconfiguration

P802.1Qav – Forwarding and Queuing for Time Sensitive Streams

- Defines a “Credit-based shaper” de-queuing algorithm for use in Bridges
  - Stream transmission possible only if credit is not exhausted
  - Credit is accumulated in proportion to the reserved bandwidth on the Bridge port
  - Has the effect of limiting the bandwidth that can be used for streaming to the amount reserved by SRP
  - Ensures that stream traffic takes priority over all other traffic
  - Ensures that the stream latency is bounded and can be calculated for a given configuration

P802.1BA – AVB Systems

- This defines a number of “profiles” for different applications
  - Consumer – AVB in the home
  - Professional/studio
  - Automotive
  - Industrial
- Each profile selects options from the base standards (802.1Q, 802.1Qat, 802.1Qav, 802.1AS, 802.3, 802.11…etc) that are appropriate for the application
- The standard may also define additional functions that don’t have a convenient home elsewhere
  - E.g., detection of unacceptable configurations

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And the “data centre” guys want a piece of 802.1 Bridging too…

- Data centre (“server farms”) and “backplane” use of Ethernet brings a new set of requirements for Bridging:
  - Very stringent requirements on latency and jitter
  - Active handling of congestion to avoid the impact of frame discard and retransmission
  - Result: drive to invent new Congestion Management mechanisms in LANs
- Not as big a market as AV, but the product value will be high

DCB standard developments – 1:

- P802.1Qau, Congestion Notification:
  - Defines a means of signalling congestion back to the source of congestion
  - Result is minimal discard rate
- P802.1Qaz, Enhanced Transmission Selection:
  - Defines a means of bandwidth sharing among traffic classes

DCB standard developments – 2:

- P802.1Qbb, Priority-based flow control:
  - Extends the existing 802.3 Pause to operate on a per-priority basis. Also involves a minor change to the 802.3 MAC control frame under P802.3bd.
- Future project, P802.1Qbg, Edge Virtual Bridging:
  - Extends the Bridging standards to support virtual machine developments within desktop and server systems

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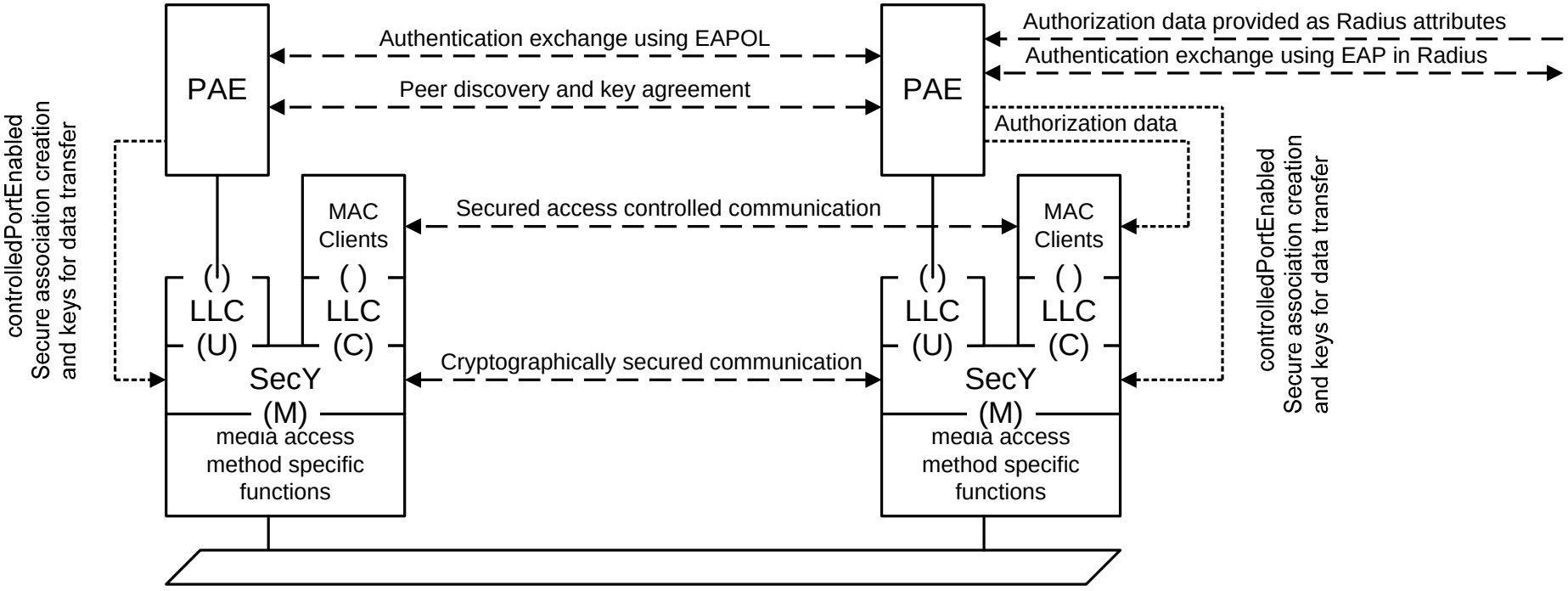
The 802.1 Security standards: 1

- 802.1X:2004 Port based Network Access Control:
  - Defines a “Controlled Port” accessible only after EAP-based authentication, and an “Uncontrolled Port” accessible at any time
  - 2009 revision adds “key agreement” protocol
- 802.1AE:2006 MAC Security:
  - Defines a means of securing data on an individual LAN segment
  - Integrated with the key agreement and controlled/uncontrolled Port functions in 802.1X

Security architecture



Legend: –( )– Port –(C)– Controlled Port –(U)– Uncontrolled Port –(M)– Common Port

---------- LMI communication

The 802.1 Security standards: 2

- P802.1AR Secure Device Identity:
  - Defines unique per-device identifiers
  - Allows standard mechanisms to authenticate a device's identity
  - Facilitates secure device provisioning

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More information is available on IEEE 802.1 standards and activities here…

http://www.ieee802.org/1/

Free PDF copies of IEEE 802 standards available from…

http://standards.ieee.org/getieee802/index.html

…but only 6 months after publication

Summary of 802.1 Standards and Projects (1) - Bridging

- Base Bridging standards (published):
  - IEEE Std 802.1D:2004, MAC Bridges
  - IEEE Std 802.1Q:2005, Virtual Bridged Local Area Networks
- Amendments to IEEE Std 802.1Q:2005 (published):
  - IEEE Std 802.1ad:2005 – Provider Bridging
  - IEEE Std 802.1ag:2007, Connectivity Fault Management
  - IEEE 802.1ak:2007, Multiple Registration Protocol
  - IEEE 802.1Q:2005 Cor 1:2008 (bug fix for 802.1ak)
  - IEEE 802.1ah:2008, Backbone Provider Bridges
  - IEEE 802.1ap:2008, MIB definitions for VLAN Bridges

Summary of 802.1 Standards and Projects (2) - Bridging

- Amendments to IEEE Std 802.1Q:2005 (active projects, with probable completion date):
  - P802.1aj, Two-port MAC Relay (Submitted for Standards Board approval in December 2009)
  - P802.1Qav, Forwarding & Queuing for Time Sensitive Streams. (Submitted for Standards Board approval in December 2009)
  - P802.1aq, Shortest Path Bridging (Working Group ballot; Completion Dec 2010)
  - P802.1Qat, Stream Reservation Protocol. (Starts Sponsor Ballot in December; completion July 2010)
  - P802.1Qau, Congestion Notification. (Sponsor ballot; completion July 2010)
  - P802.1Qaz, Enhanced Transmission Selection. (Task Group ballot; completion 2011)
  - P802.1Qbb, Per-priority flow control. (Task Group ballot ; completion 2011)
  - P802.1Qbc – Remote Customer Service Interface. (Task Group ballot ; completion 2011)
  - P802.1Qbe – Multiple I-SID Registration Protocol. (Task Group ballot ; completion 2011)
  - P802.1Qbf – PBB-TE infrastructure protection. (Task Group ballot ; completion 2011)

Summary of 802.1 Standards and Projects (3) - Security

- Published standards:
  - IEEE Std 802.1X:2004, Port-based Network Access Control
  - IEEE Std 802.1AE:2006, MAC Security
- Active projects:
  - P802.1X, Port-based Network Access Control. (Revision project; submitted for Standards Board approval December 2009)
  - P802.1AR, Secure Device Identity. (Submitted for Standards Board approval December 2009)

Summary of 802.1 Standards and Projects (4) – The rest…

- Published standards:
  - IEEE Std 802:2001, Overview and Architecture
  - IEEE Std 802a:2003, Ethertypes for Prototype and Vendor-Specific Protocol Development
  - IEEE Std 802b:2004 Registration of Object Identifiers
  - IEEE Std 802.1H:1995, MAC Bridging of Ethernet (currently under revision)
- Active projects:
  - P802.1AS, Time Synchronization (Expected to start Sponsor balloting in December 2009)
  - P802, Overview and Architecture (Expected completion December 2011)
  - P802.1AC, MAC Service Definition (Expected completion December 2010)
  - P802.1H:1995, MAC Bridging of Ethernet (Revision project. Expected completion December 2010)