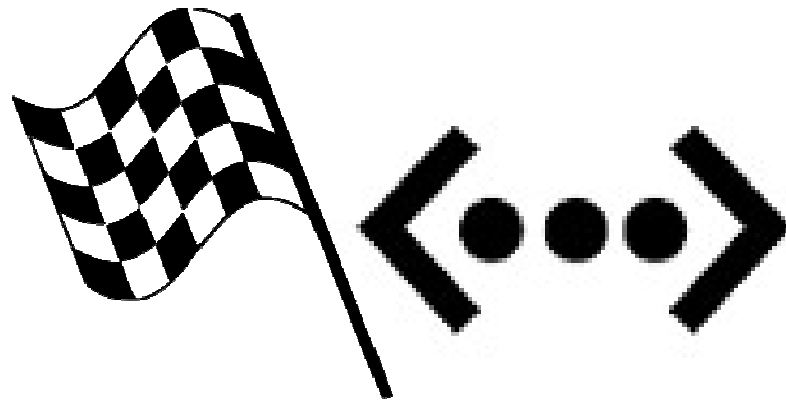




# 40 AND 100 GIGABIT ETHERNET OVERVIEW

Greg Hankins <[ghankins@brocade.com](mailto:ghankins@brocade.com)>

UKNOF16





# Agenda

- Standards Update
- Form Factor and Cabling
- Timeline (ie When can I have it?)
- Market and Pricing Trends

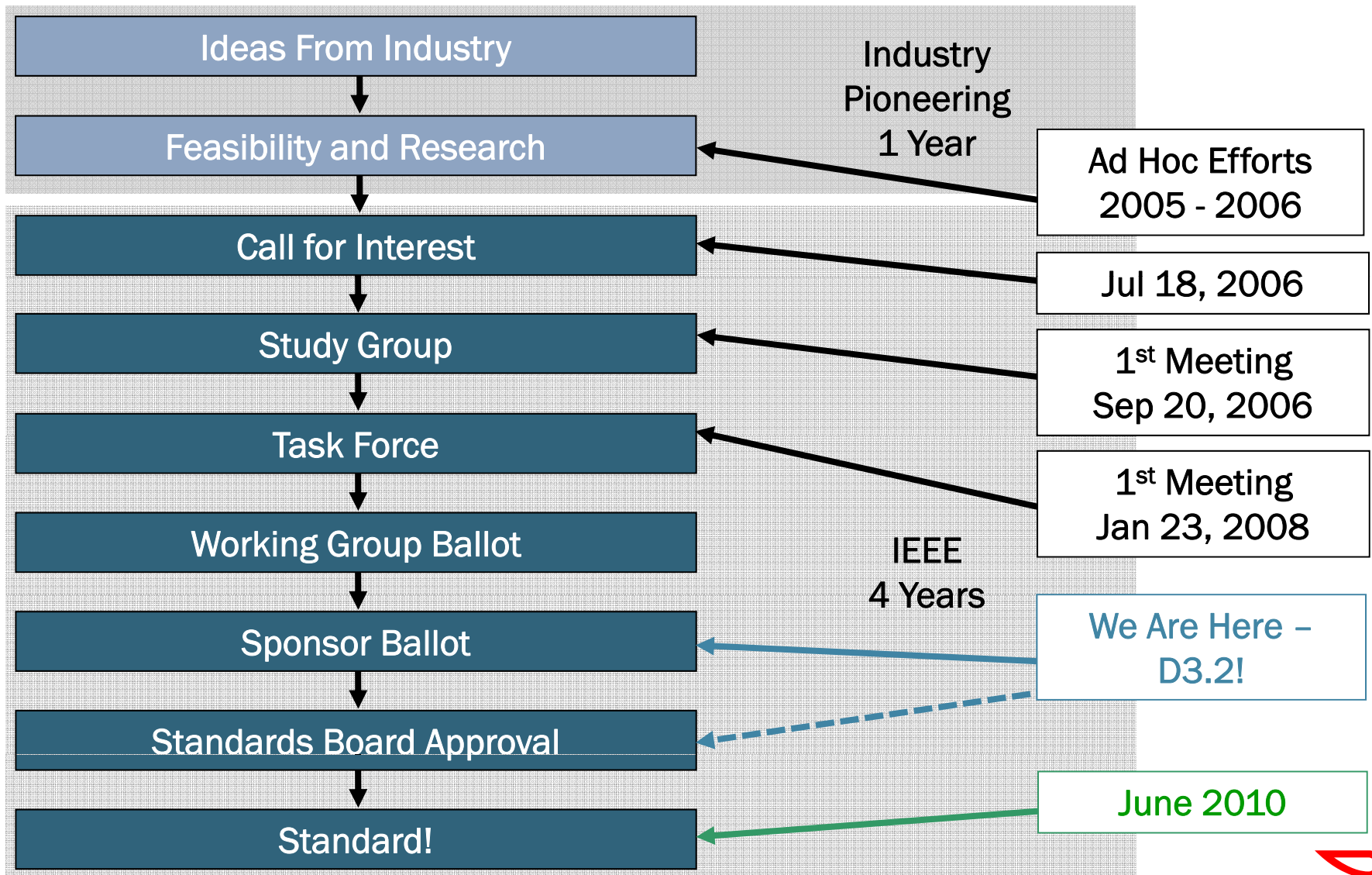
# Summary of Recent IEEE 802.3ba Developments

- Lots of activity to finalize the new standards specifications
  - Many changes in 2006 – 2008 as objectives were first developed
  - Last technical change in November 2009
  - Comment resolution, crossing Is and dotting Ts
- Proceeded to state of “STOP MAKING CHANGES” in March meeting
  - Draft 3.2 looks like the final draft
  - April meeting cancelled
- On schedule: the 40 and 100 GbE standards will be delivered together in June 2010

## Recent Industry Activity

- First generation pre-standard announcements in 2009
  - ASICs
  - Media modules
  - Test equipment interfaces
  - Router interfaces
- Technology demonstrations and forums in 2009/2010
  - Test equipment vendors had early demos in May 2009 at Interop
  - 40 GbE and 100 GbE CFP demos in September 2009 at ECOC
  - Ethernet Alliance white papers and education efforts
  - 100 GbE 10 km CFP demos at March 2010 OFC

# Where are we now after 5 years?



# Future Meetings

- ~~April 2010 Interim (cancelled)~~
  - ~~April 20, San Jose, CA, USA~~
- May 2010 Interim (*if needed*)
  - May 24 – 28, Geneva, Switzerland
- *June 2010 – Finished Standard!*
- Meeting information:  
<http://ieee802.org/3/interims/index.html>
- IEEE P802.3ba 40 Gb/s and 100 Gb/s Ethernet Task Force  
Public Area:  
<http://grouper.ieee.org/groups/802/3/ba/index.html>

# Summary of Reach Objectives and Physical Layer Specifications – Updated July 2009

Physical Layer Reach	1 m Backplane	7 m Copper Cable	100 m OM3, 125 m OM4 MMF	10 km SMF	40 km SMF
----------------------	---------------	------------------	--------------------------	-----------	-----------

## 40 Gigabit Ethernet: *Target Applications – Servers, Data Center, Campus, Metro, Backbone*

Name	40GBASE-KR4	40GBASE-CR4	40GBASE-SR4	40GBASE-LR4	
Signaling	4 x 10 Gb/s	4 x 10 Gb/s	4 x 10 Gb/s	4 x 10 Gb/s	
Media	Copper Backplane	Twinax Cable	MPO MMF	Duplex SMF	
Module/Connector		QSFP Module, CX4 Interface	QSFP Module	QSFP Module, CFP Module	
Availability	No Known Development	2010	2010	QSFP 2011-2012 CFP 2010	

## 100 Gigabit Ethernet: *Target Applications – Data Center, Campus, Metro, Backbone, WAN*

Name		100GBASE-CR10	100GBASE-SR10	100GBASE-LR4	100GBASE-ER4
Signaling		10 x 10 Gb/s	10 x 10 Gb/s	4 x 25 Gb/s	4 x 25 Gb/s
Media		Twinax Cable	MPO MMF	Duplex SMF	Duplex SMF
Module/Connector		CXP Module	CXP Module, CFP Module	CFP Module	CFP Module
Availability		2010	2010	2010	2011-2012

# 40 GbE QSFP Modules

- Created for high density short reach interfaces
  - Targeted for data center applications
- Used for a variety of Ethernet and InfiniBand applications including 40GBASE-CR4 and 40GBASE-SR4
  - 4 bidirectional channels
  - Low power consumption
- Preferred optical module for 40 GbE because of small form factor and cost
- Specifications defined to support 40GBASE-LR4 but QSFP not expected until 2011-2012
- Same faceplate size as an XFP but slightly shorter (8.5 mm high x 18.35 mm wide x 52.4 mm long)
  - Small compact form factor enables high density but limits distance



Mellanox MMF and Twinax Copper QSFP Assemblies



# 100 GbE CXP Modules

- Created for high density short reach interfaces
  - Targeted for data center applications
- Used for 100GBASE-CR10, 100GBASE-SR10 and InfiniBand 12X QDR
  - 12 bidirectional channels/24 fibers
  - 100 GbE uses 10 of the 12 channels
- Slightly larger than an XFP (27 mm wide x 45 mm long)
  - Small compact form factor enables high density but limits distance



Finisar C.wire MMF CXP Assembly

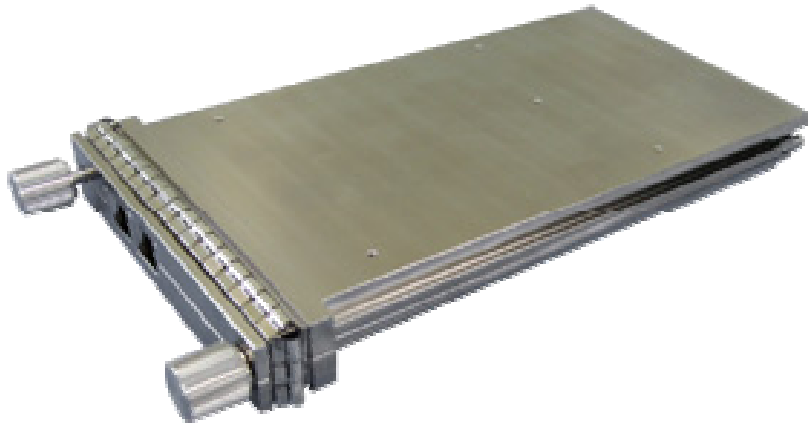
# 40 and 100 GbE CFP Modules

- New module optimized for longer reach applications
- Used for 40GBASE-SR4, 40GBASE-LR4, 100GBASE-SR10, 100GBASE-LR4 and 100GBASE-ER4
  - Dense electrical connector enables a variety of interfaces
  - Integrated heat sink allows efficient cooling
  - 100 GbE modules are complicated because of 10 Gb/s to 25 Gb/s conversion
- About twice as wide as a XENPAK (14 mm high x 82 mm wide x 130.25 mm long)
- 100GBASE-ER4 not expected until 2011-2012



Finisar CFP Assembly

# 40 and 100 GbE CFP Module Examples



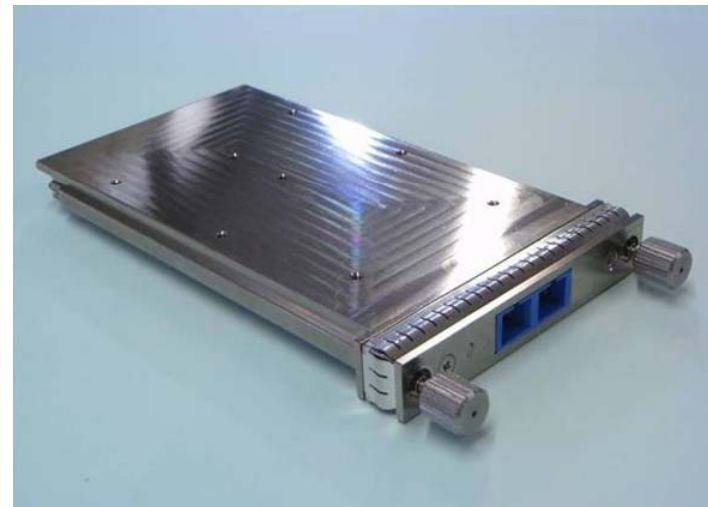
Opnext 100GBASE-LR4



Reflex Photonics Dual 40GBASE-SR4



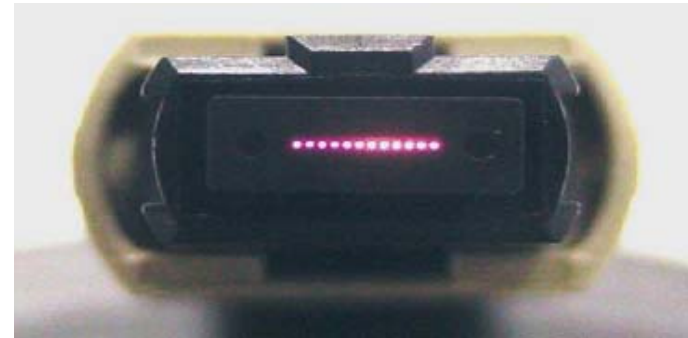
Reflex Photonics 100GBASE-SR10



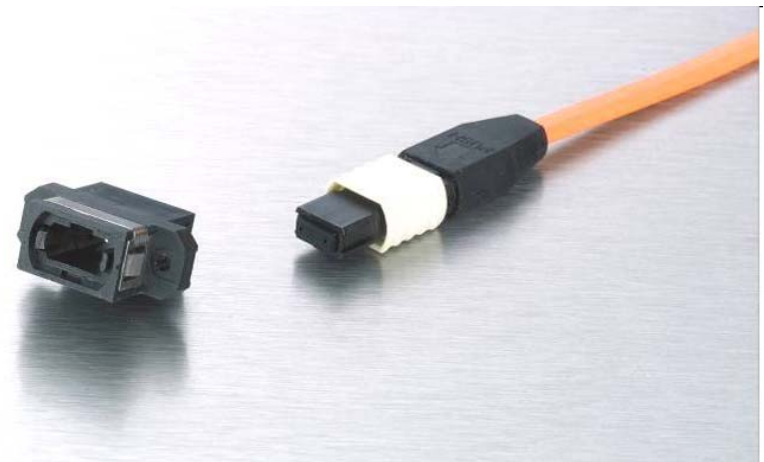
Sumitomo Electric Industries 40GBASE-LR4

# MPO/MTP Cable Assemblies

- MPO = “Multi-fiber Push On” assembly
  - Also called MTP by Corning
- Wide variety of high density cabling options
  - MPO to MPO
  - MPO cassette for patch panels
  - MPO breakout into SC, LC, etc
- 40GBASE-SR4
  - 12 fiber MPO cable, uses 8 fibers
- 100GBASE-SR10
  - 24 fiber MPO cable, uses 20 fibers
- May require new ribbon fiber infrastructure



12 Fiber MPO Cable



Fibernet MTP/MPO Cable

# Second Generation Technology

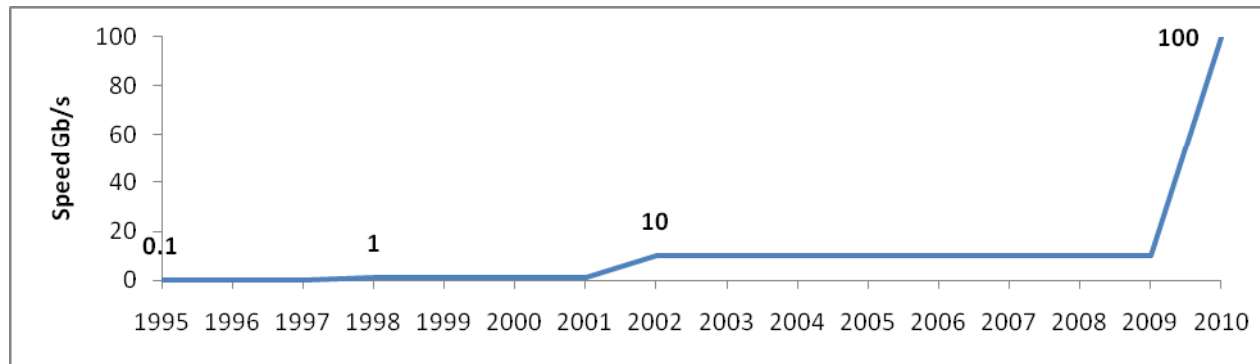
- There will be demand for other interfaces beyond the scope of 802.3ba
  - Standard defines a flexible architecture that enables many implementations as technology changes
- The second generation of 40 Gigabit Ethernet is being defined in a new IEEE project
  - 4 x 10 Gb/s electrical interface with a 1 x 40 Gb/s optical output over 2 km SMF  
<http://www.ieee802.org/3/40GSMF/index.html>
- The second generation of 100 Gigabit Ethernet will use 4 x 25 Gb/s interfaces
  - The OIF is doing fundamental work on 25 Gb/s signaling which will make newer interfaces and optics modules possible
  - The 4 x 25 Gb/s electrical interface is being defined in the OIF and should be finished in April 2011
  - The 4 x 25 Gb/s 100 GbE multimode interface will need to be defined in the IEEE and might complete in 2012/2013



# Agenda

- Standards Update
- Form Factor and Cabling
- Timeline (ie When can I have it?)
- Market and Pricing Trends

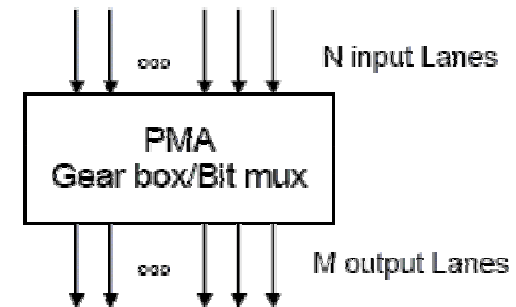
## Timing – Are 40 and 100 GbE Late?



- Bandwidth requirements from network operators clearly show there is a need for it
  - But only if it cost less than  $n \times 10$  GbE
- Careful timing between market demand vs available technology
  - No customers - if developed before the market is ready
  - Too expensive - if developed too early and the component technology isn't affordable
- If we started working on higher speed Ethernet earlier...
  - It probably would be more expensive than it is now, based on the technology that was available
  - Reusing a lot of available 10 Gb/s and component technology that has come down in price

# Development Challenges

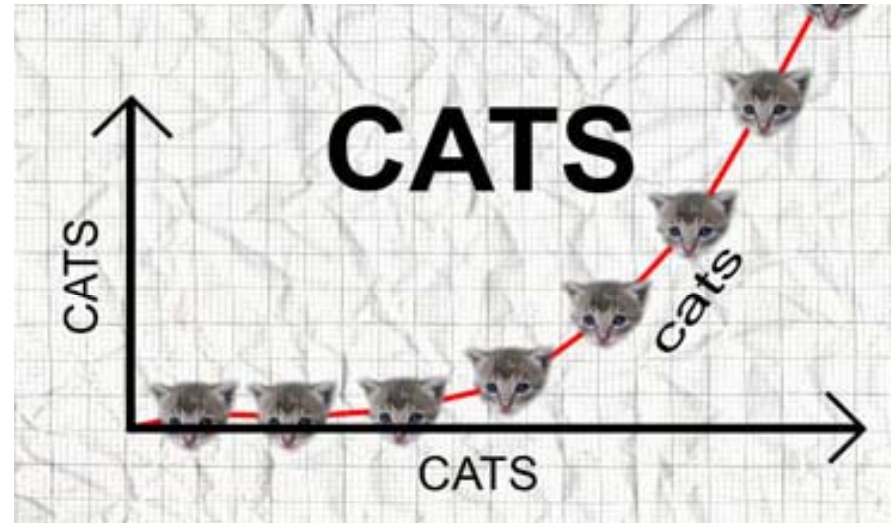
- 40 GbE is relatively easy to implement based on existing 10 GbE technology and vendor intellectual property
  - Initial 40 GbE implementations use 4 x 10 Gb/s lanes and existing optics modules
  - Mostly integration work instead of development work
- 100 GbE requires a lot of R&D investment
  - New ASICs
  - New components
  - New optics modules
- 100 GbE optics are about 4 times as expensive as 40 GbE optics
  - Requires 10:4 gear box (converts 10 x 10 Gb/s into 4 x 25 Gb/s)
  - Current shortage of gear box components
  - 25 Gb/s lasers
- CFP media modules are currently extremely expensive as optics vendors run sample productions in volumes of 10s



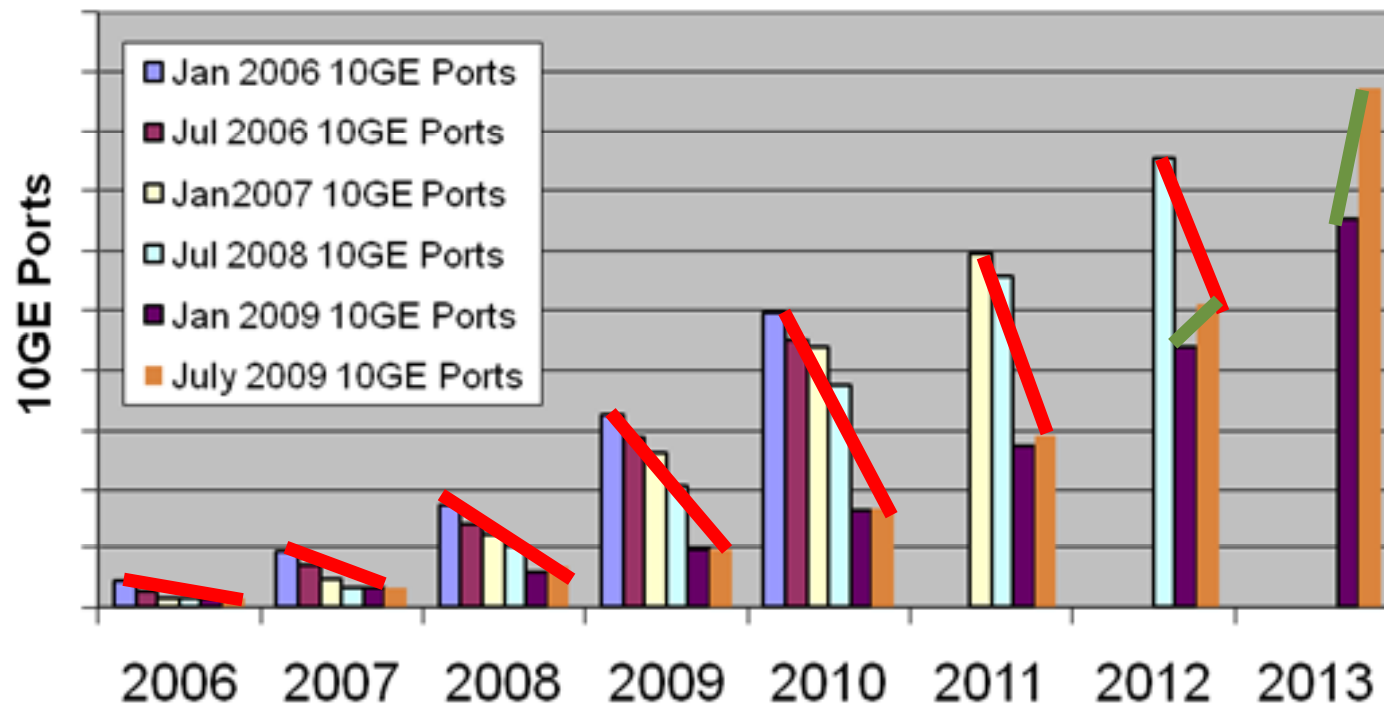


# Ethernet Market Prediction Challenges

- Sizing and predicting market demand is extremely difficult, at best it is educated guesstimation
- Many 10 GbE vendors were burned by lofty projections and market sizing
  - Initially hesitant to invest in 100 GbE R&D
  - Some still consider 10 GbE to be a failure in terms of living up to market projections

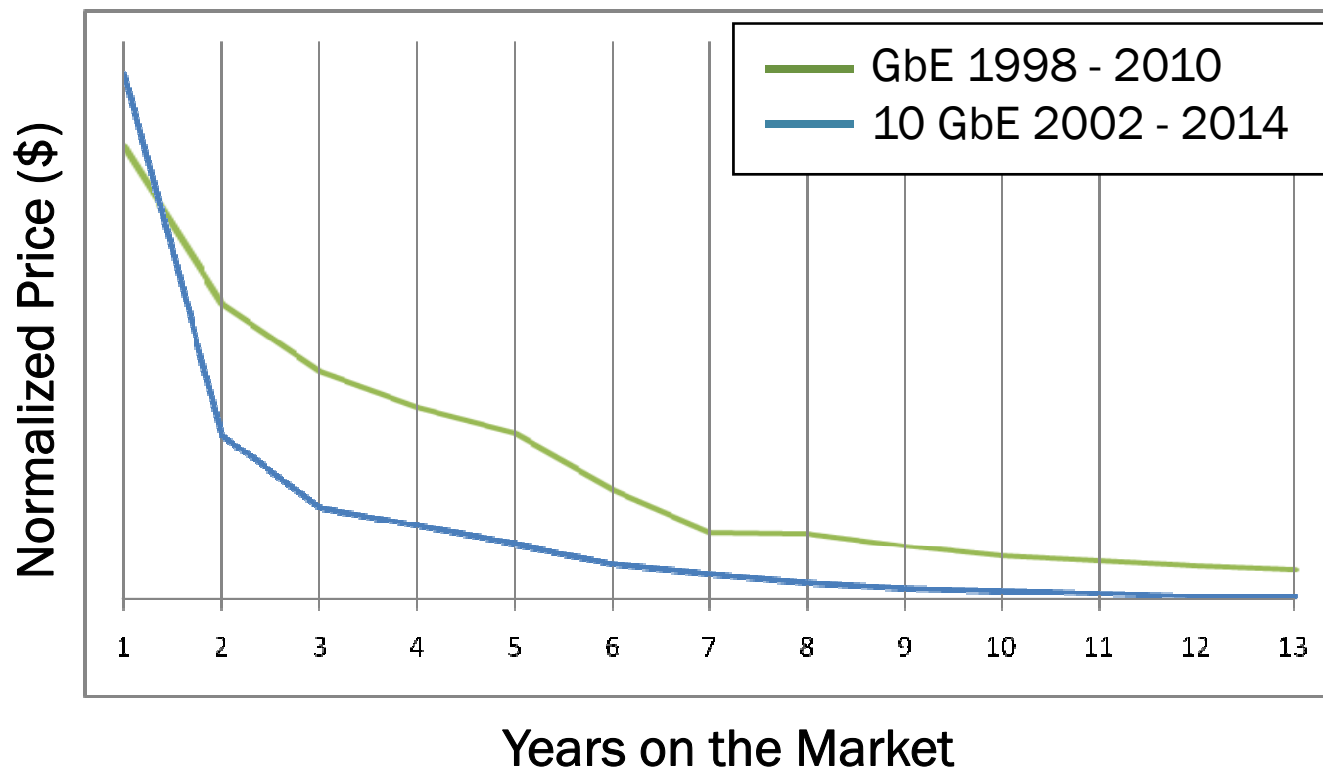


# Dell'Oro 10 GbE Port Projections 2006 - 2009



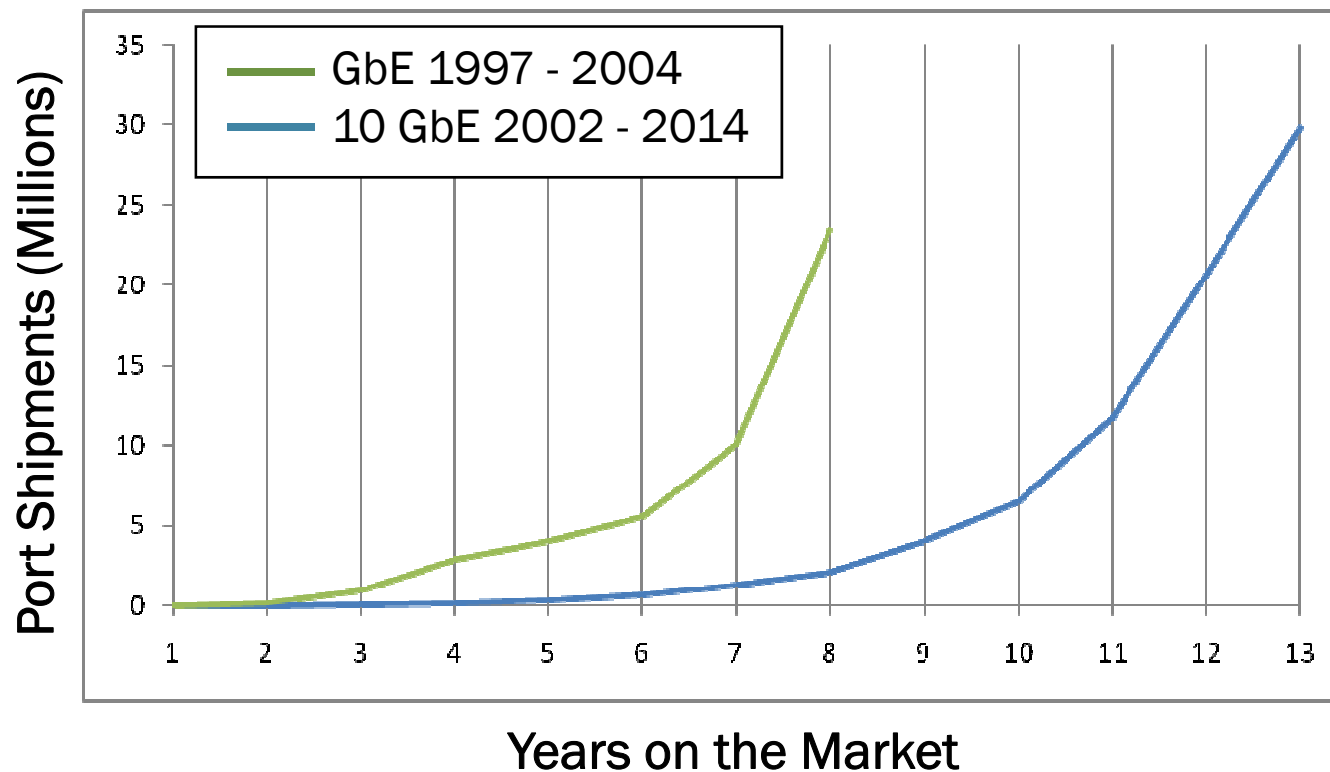
- Number of ports shipped is much lower than predicted, especially in later years as the market matured
- Finally seeing an increase in 2012/2013 projections based on reality, ten years after the 10 GbE standard in 2002

# Ethernet Average Selling Price (ASP) Trends



- Prices of previous Ethernet generations fell significantly during the first few years on the market
- Expect the same thing to happen with 40 GbE and 100 GbE

# Ethernet Port Shipment Trends



- The 10 GbE market had a significantly longer ramp up curve than GbE
- Market predictions for 40 GbE are in the low 1000s in the first years
- 10s of 100 GbE interfaces are likely to ship this year, 100s next year

## Predictions Summary

- Based on historical GbE and 10 GbE prices, we can expect 40 and 100 GbE prices to fall significantly in 2011/2012
  - Volume production and 2<sup>nd</sup> generation technology will increase density and lower prices
- Consider the whole cost of a link when comparing prices of n x 10 GbE LAG vs 40 or 100 GbE
  - Router line cards, ports and optics
  - Optical and transport gear
  - Fiber
  - Provisioning, management and troubleshooting

# What You Should Expect This Year

- The finished standard!
- Lots of announcements from vendors
- First generation technology will be expensive and low density compared to current 10 GbE prices
  - Technology cost choices were chosen so 100 GbE will be cheaper than 10 x 10 GbE as the industry matures
  - Initially an application for early adopters
  - In the near term, n x 10 GbE LAG may be more cost effective for you
  - Higher speed interfaces will make 10 GbE denser and cheaper in the future
- Density will improve as switch/router vendors develop higher capacity systems
  - Reasonable density requires several hundred Gbps/slot for multiple ports
  - Moving from gigabit and ten gigabit to terabit router architectures
- Cost will decrease as new technology becomes feasible and volume increases
  - Optics and component costs are higher initially

# What You Should Do

- Look at your network growth and needs in 3 – 5 years
- Ask for roadmaps
  - Optical gear and switch/router vendors
  - Server vendors
  - Transport and IP transit providers, IXs
  - Others?
- Figure out what is missing and ask for it
  - Will it work with your optical network?
  - What about your cabling infrastructure?
  - Do the speeds and reaches meet your needs?

# Crystal Ball for the Future

- No one is asking for networks to be slower
  - Traffic will continue to increase
  - Interfaces speeds will continue to scale
- The need for Terabit Ethernet is already being discussed in the industry and by network operators
  - 400 Gb/s Ethernet is a likely choice by expanding 4 x 25 Gb/s to 16 x 25 Gb/s signaling
- Ethernet will continue to evolve as network and bandwidth requirements change



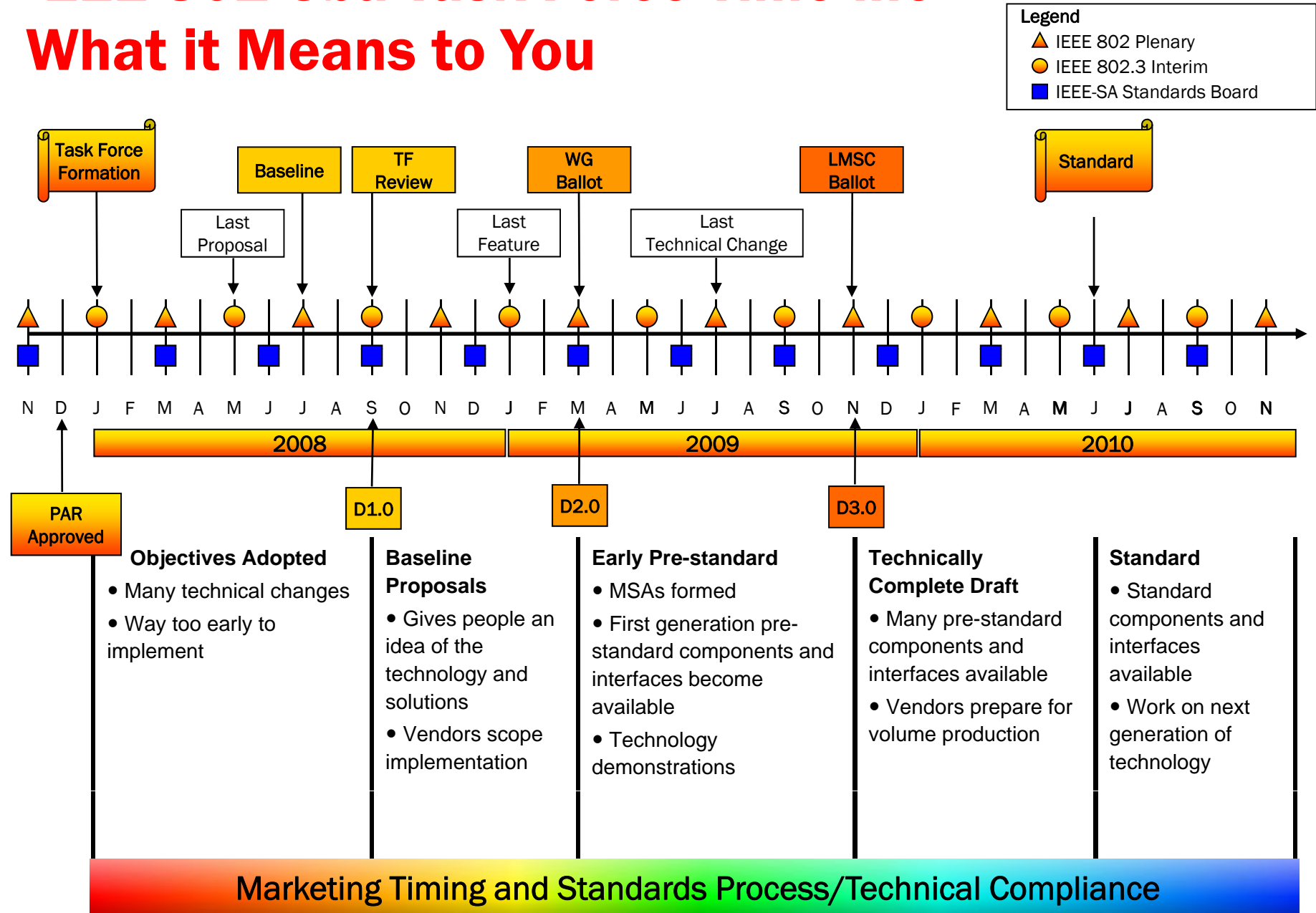


## Questions?

Many interesting references follow this slide!



# IEEE 802.3ba Task Force Timeline – What it Means to You



# Project Comparison with 10 GbE

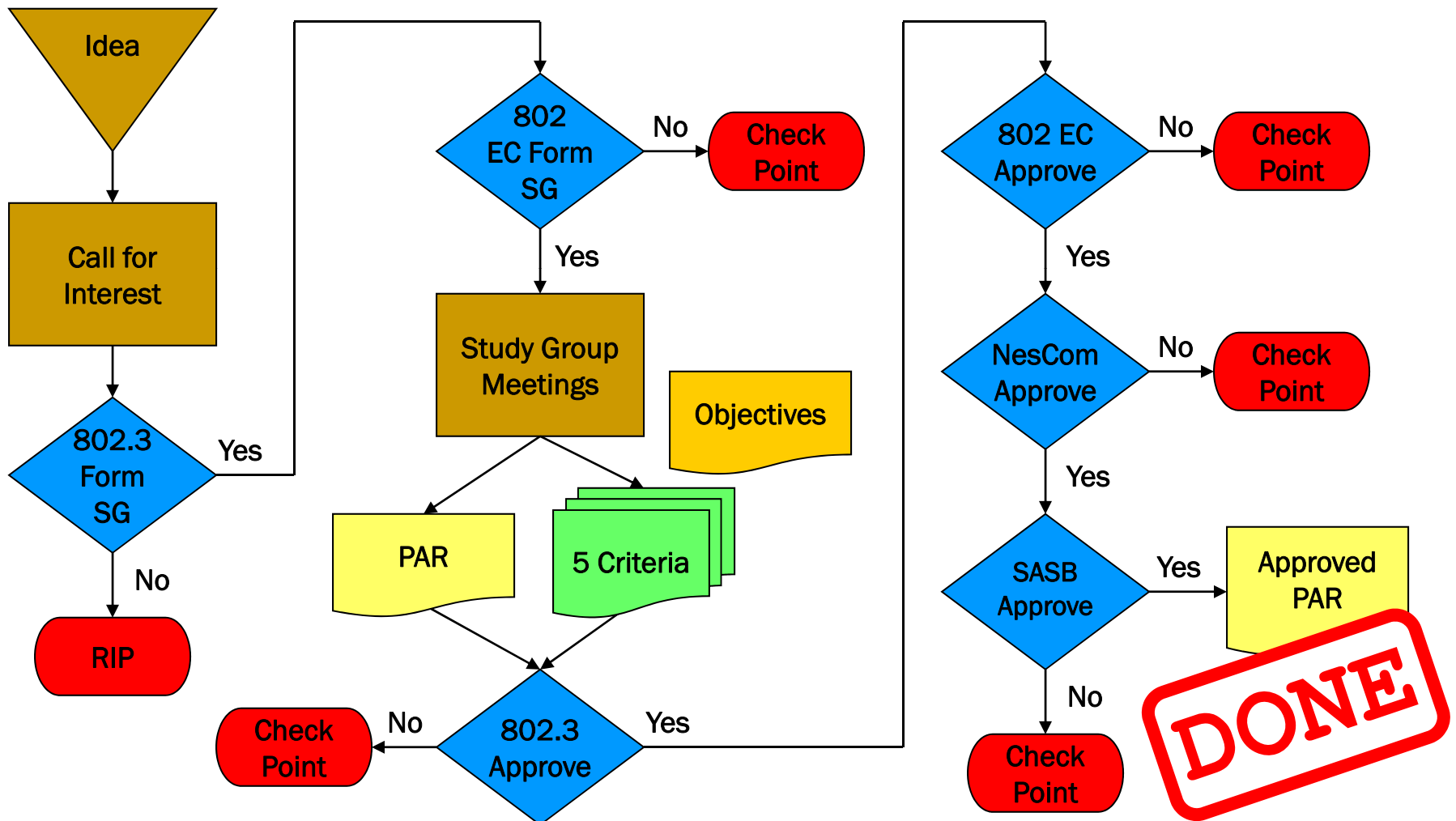
	802.3ae 10 GbE	802.3ak 10GBASE- CX4	802.3an 10GBASE- T	802.3aq 10GBASE- LRM	802.3ap 10GBASE- KR	802.3ba 40 GbE and 100 GbE
<b>Date</b>	Jun 2002	Feb 2004	Jun 2006	Sep 2006	Mar 2007	Jun 2010
<b>MMF</b>	✓			✓		✓ (40 / 100)
<b>10 km SMF</b>	✓					✓ (40 / 100)
<b>40 km SMF</b>	✓					✓ (100)
<b>80 km SMF</b>	✓ (not specified in 802.3ae)					
<b>Copper Cable</b>		✓	✓			✓ (40 / 100)
<b>Backplane</b>					✓	✓ (40)

## 803.3ba Nomenclature Suffix Summary

Speed	Medium		Coding Scheme	Lanes	
	Copper	Fiber		Copper	Optical
40G = 40 Gb/s 100G = 100 Gb/s	K = Backplane C = Copper	S = Short Reach (100 m) L = Long Reach (10 km) E = Extended Long Reach (40 km)	R = scRambled 64/66B Encoding	n = 4 or 10	n = Number of Lanes or Wavelengths
				N = 1 is not required as serial is implied.	

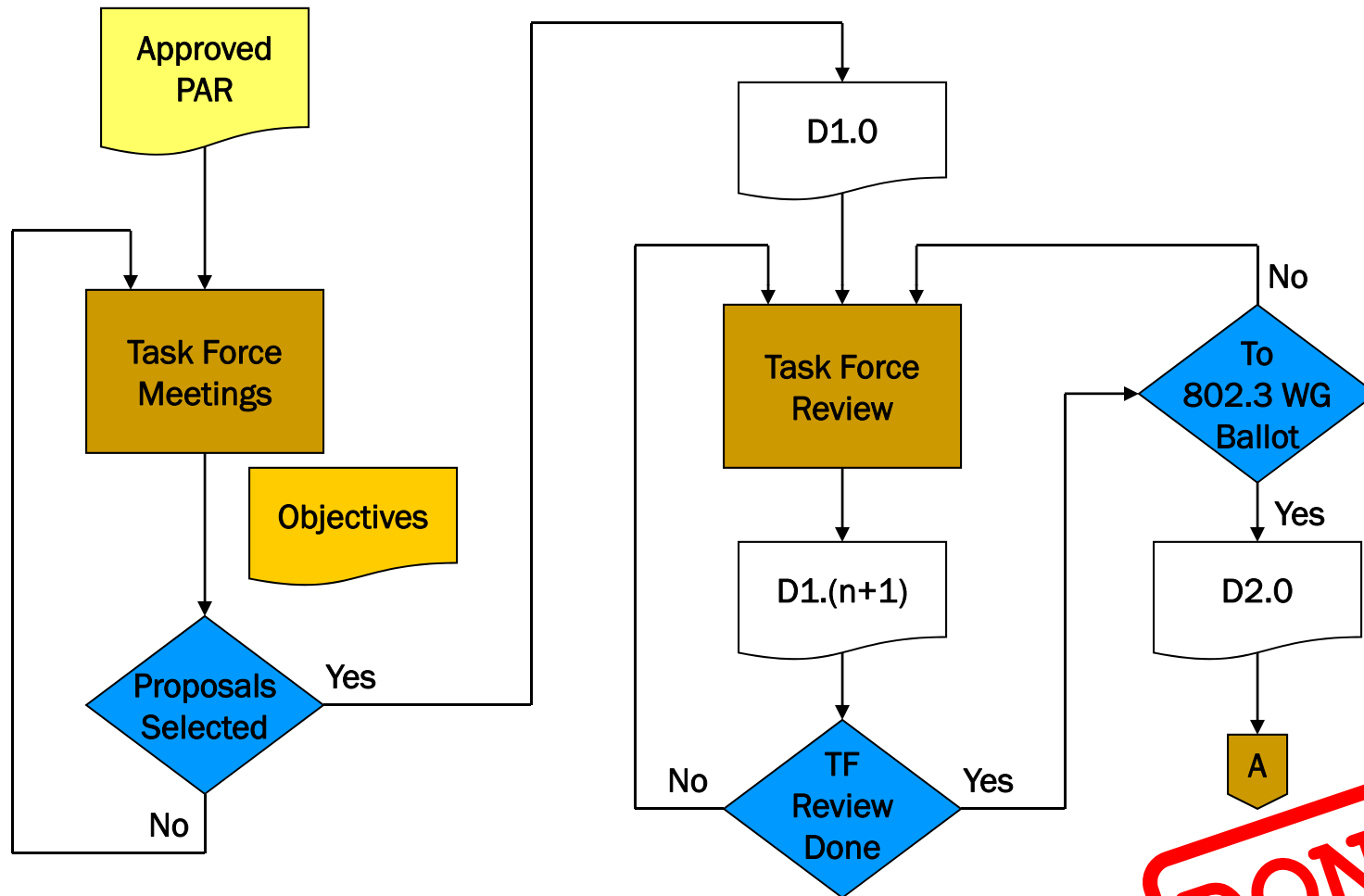
Example: 100GBASE-ER4

# Overview of IEEE 802.3 Standards Process (1/5)- Study Group Phase



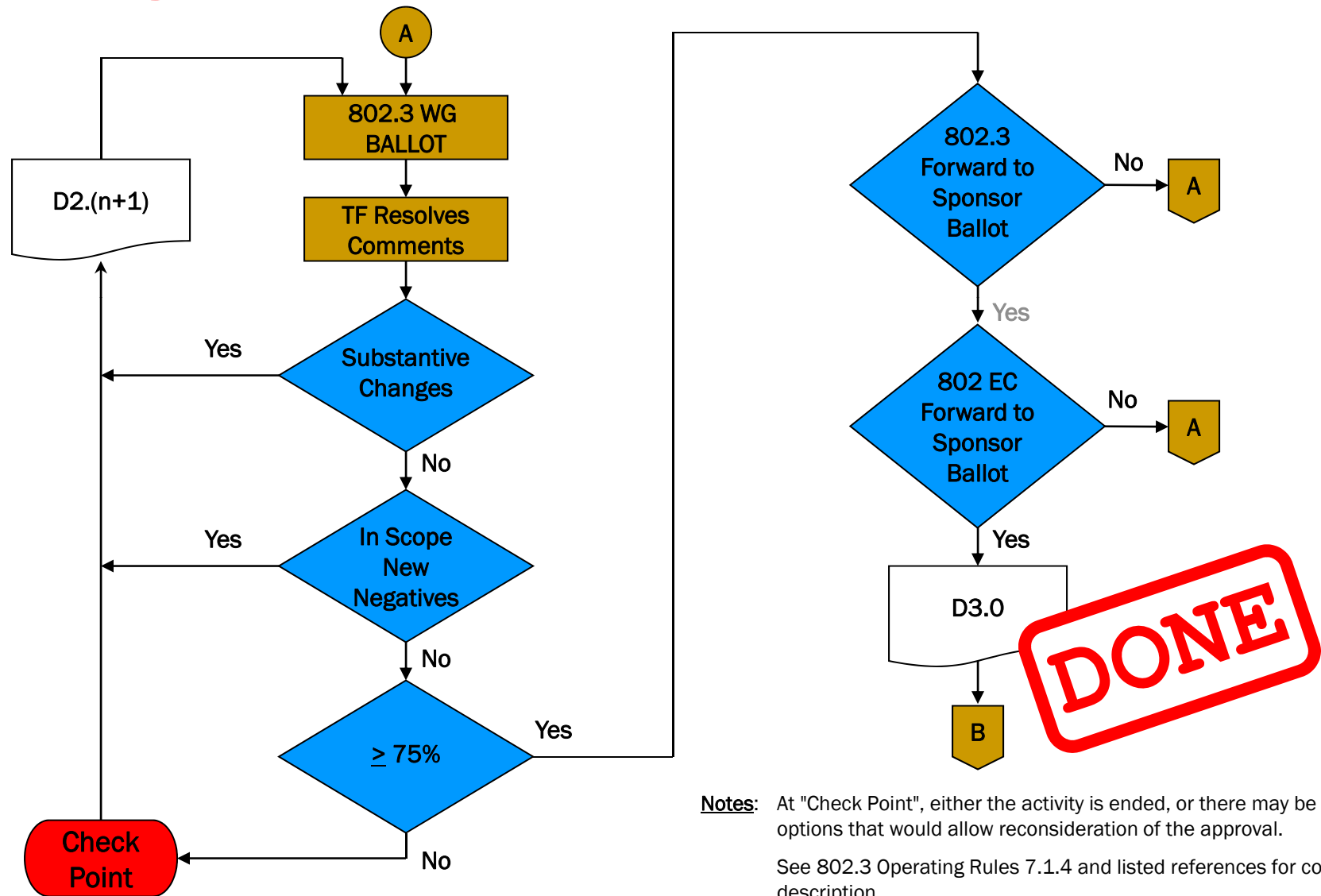
Notes: At "Check Point", either the activity is ended, or there may be various options that would allow reconsideration of the approval.

## Overview of IEEE 802.3 Standards Process (2/5) - Task Force Comment Phase



**DONE**

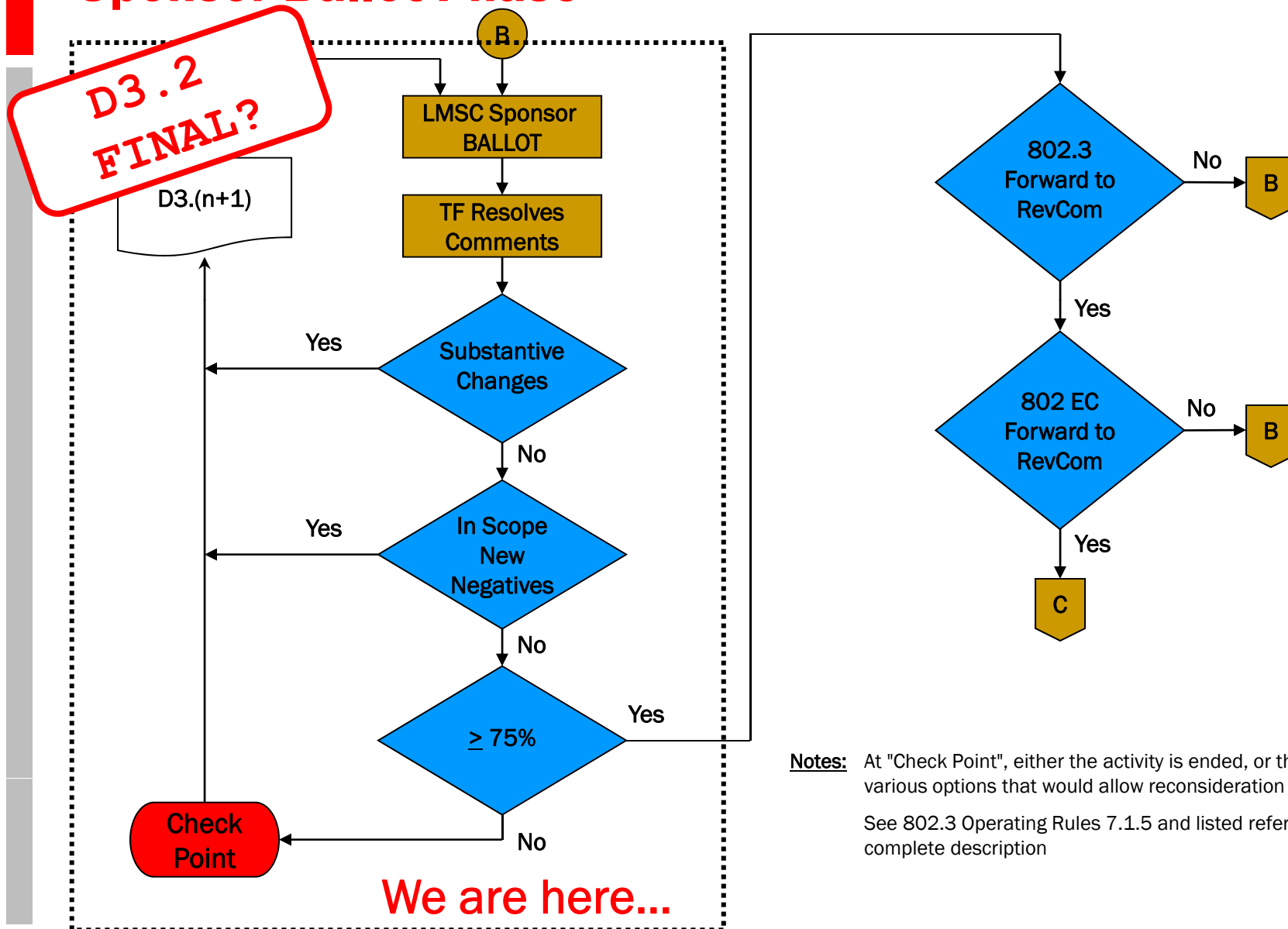
## Overview of IEEE 802.3 Standards Process (3/5) - Working Group Ballot Phase



**Notes:** At "Check Point", either the activity is ended, or there may be various options that would allow reconsideration of the approval.

See 802.3 Operating Rules 7.1.4 and listed references for complete description

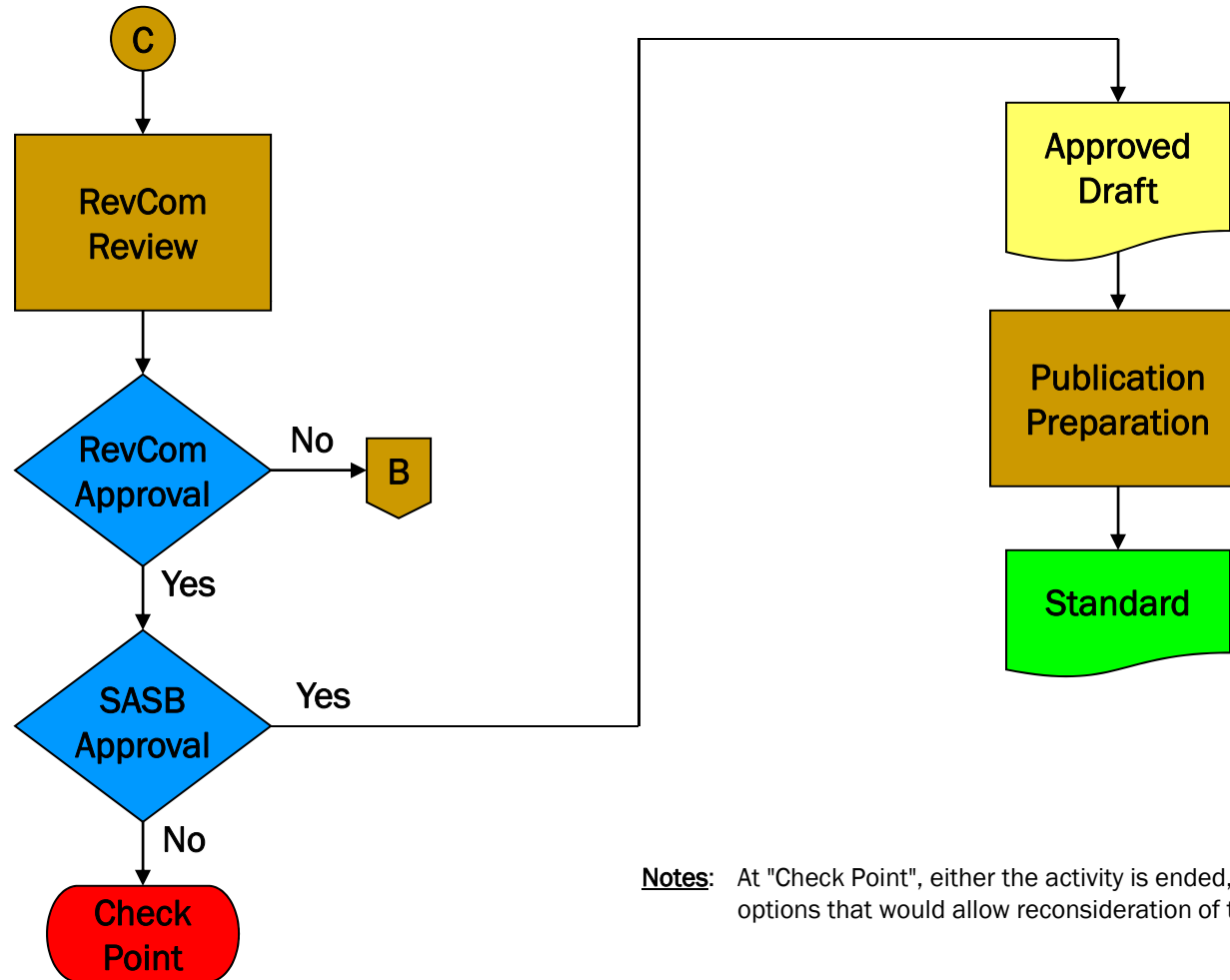
# Overview of IEEE 802.3 Standards Process (4/5)- Sponsor Ballot Phase



**Notes:** At "Check Point", either the activity is ended, or there may be various options that would allow reconsideration of the approval.  
See 802.3 Operating Rules 7.1.5 and listed references for complete description



## Overview of IEEE 802.3 Standards Process (5/5) - Final Approvals / Standard Release



**Notes:** At "Check Point", either the activity is ended, or there may be various options that would allow reconsideration of the approval.