# The Implementation of Error Checking and Optional Parameter Negotiation for BGP-4 in a Network Simulator

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# Presentation Overview

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# Acknowledgements


- Dr. Ljiljana Trajković
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- Tony D. Feng
- Nenad Lasković
- Jenny Koo and Mary Kwong
- Communication Networks Laboratory
- … several people behind-the-scenes

# Introduction

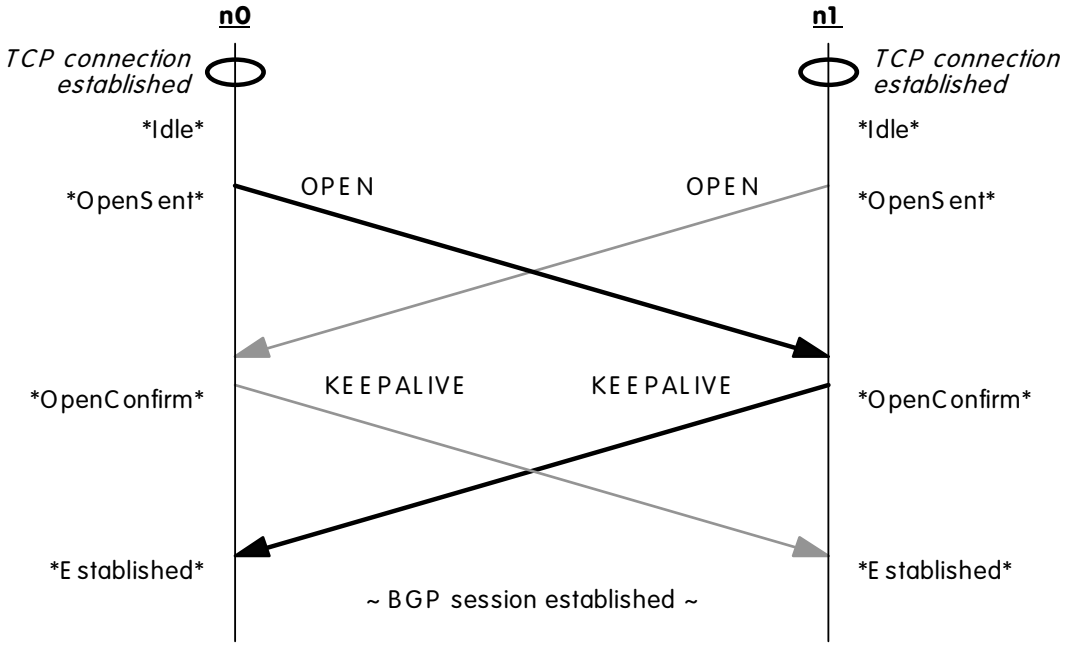
- Internet: a cluster of ASes
  - Within AS: Interior Gateway Protocols
  - Among ASes: Exterior Gateway Protocols
- Scalability and performance are key
- Interest in academic research community to investigate behaviour of networks
- Development of network simulation tools
  - SSFNet, OPNET, ns-2
- Improved accuracy of a network model better reflects actual behaviour

# Background Knowledge

- Border Gateway Protocol
  - Exterior Gateway Protocol
  - BGP-4 is the *de facto* protocol
  - Operation using 4 message types
    - OPEN
    - UPDATE
    - NOTIFICATION
    - KEEPALIVE

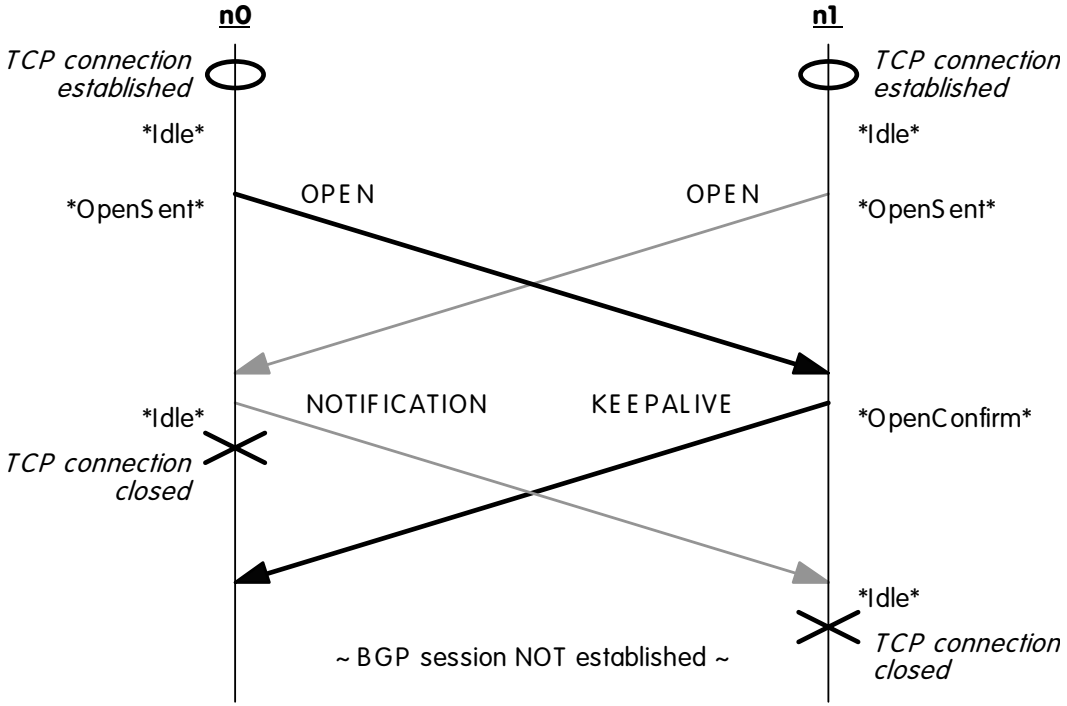
# Background Knowledge (cont'd)

- OPEN Process
  - 3-way handshaking procedure



# Background Knowledge (cont'd)

- OPEN Process
  - failed process: n0 deems parameter unacceptable



# Background Knowledge (cont'd)

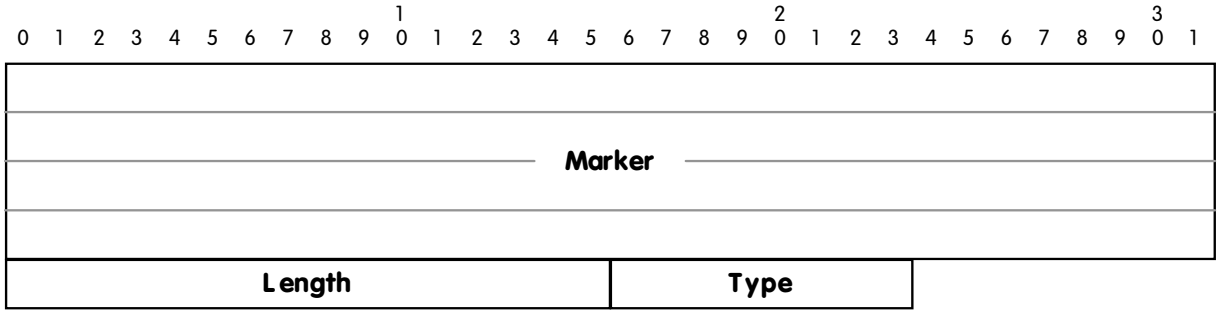
- BGP Simulation Models
  - SSFNet model SSF.OS.BGP4 by Brian J. Premore [14]
    - Java-based model
  - ns-2 model ns-BGP by Tony D. Feng [9]
    - C++/OTcl model
    - Ported over from SSFNet model

# Project Contribution

- Original project plan out the window…
- Assumptions made to simplify SSFNet model during implementation
  - Carried over to ns-BGP
- Error checking
- OPEN message Optional Parameter
- Negotiation of optional parameters

# Project Contribution: Error Checking

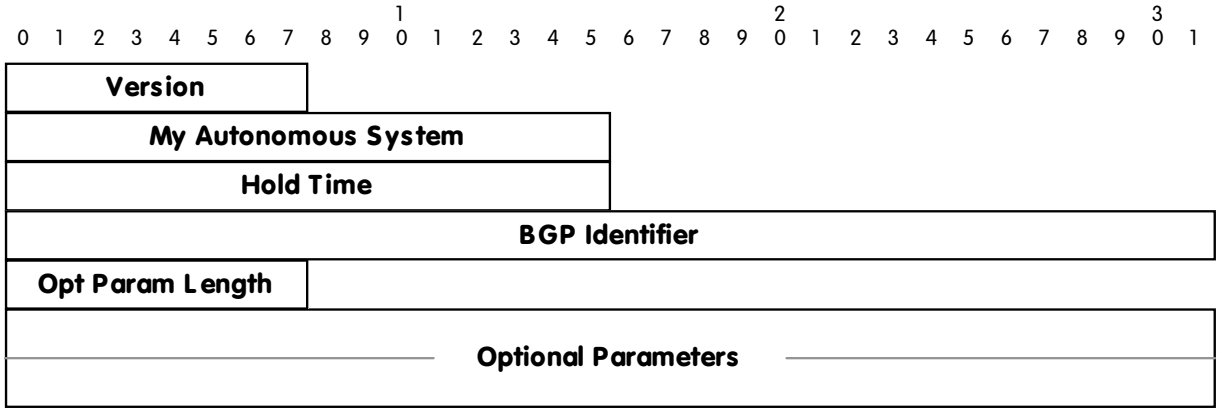
- BGP message header
  - Common 19-byte header




  - Marker: used for Authentication Information
  - Length: total length of BGP message
  - Type: OPEN, UPDATE, NOTIFICATION, KEEPALIVE

# Contribution: Error Checking (cont'd)

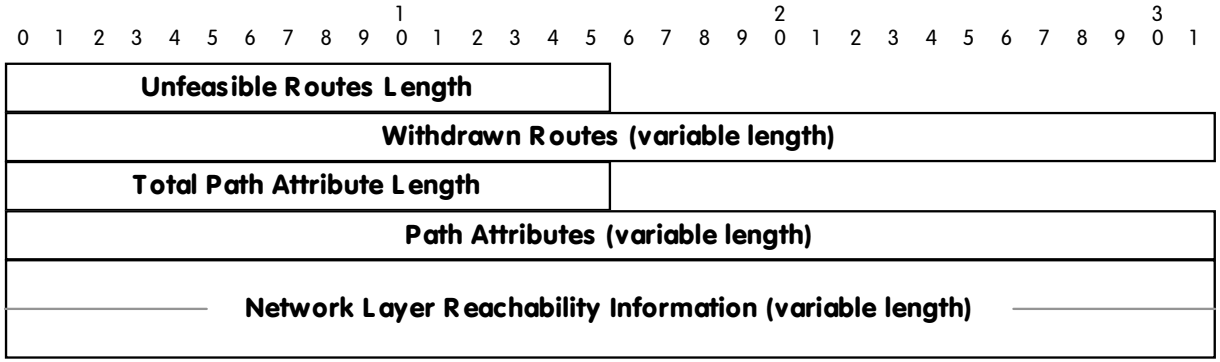
- OPEN message




  - Handshaking information
    - Identification
    - Desired session parameters

# Contribution: Error Checking (cont'd)

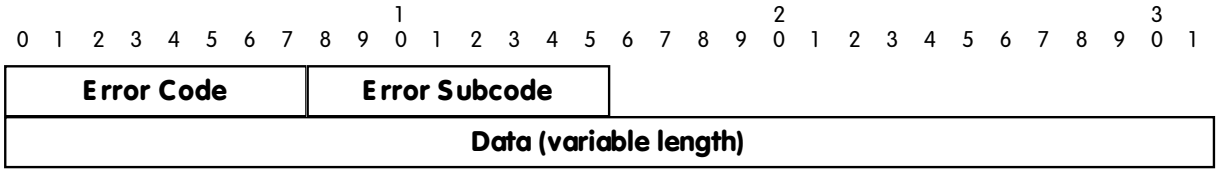
- UPDATE message




  - Unfeasible Routes
  - Path Attributes (for new routes)
  - Network Layer Reachability Information (NLRI)

# Contribution: Error Checking (cont'd)

- NOTIFICATION message

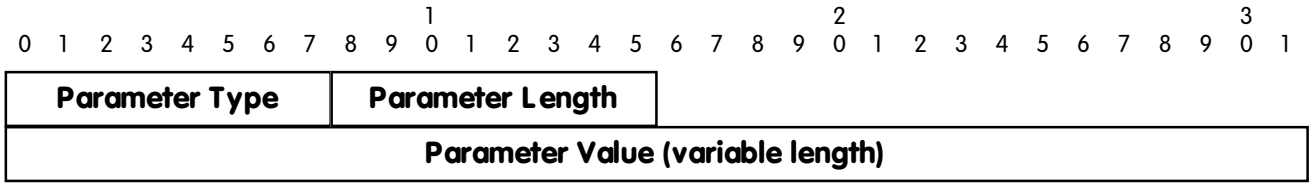



  - Sent when error occurs
  - BGP and underlying TCP connections closed

- KEEPALIVE message
  - No message body

# Contribution: Optional Parameters

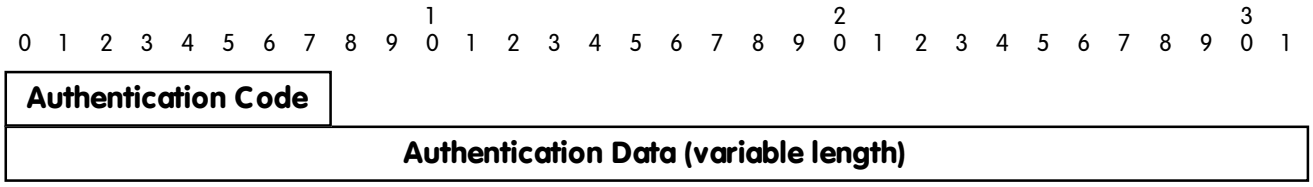
- OPEN message Optional Parameter




  - Type 1: Authentication Information
    - Contains data for specific authentication mechanism
  - Type 2: Capabilities Advertisement
    - Communicates new features to employ during BGP peering session

# Contribution: Optional Parameters (cont'd)

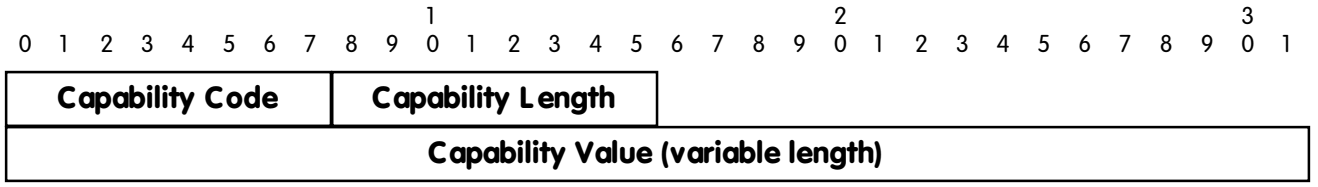
- Type 1: Authentication Information




  - Used to verify identity of sender or to detect loss of synchronisation between peers
  - Authentication Data contains algorithm for calculating value of Marker field
  - Not yet implemented by any vendors!

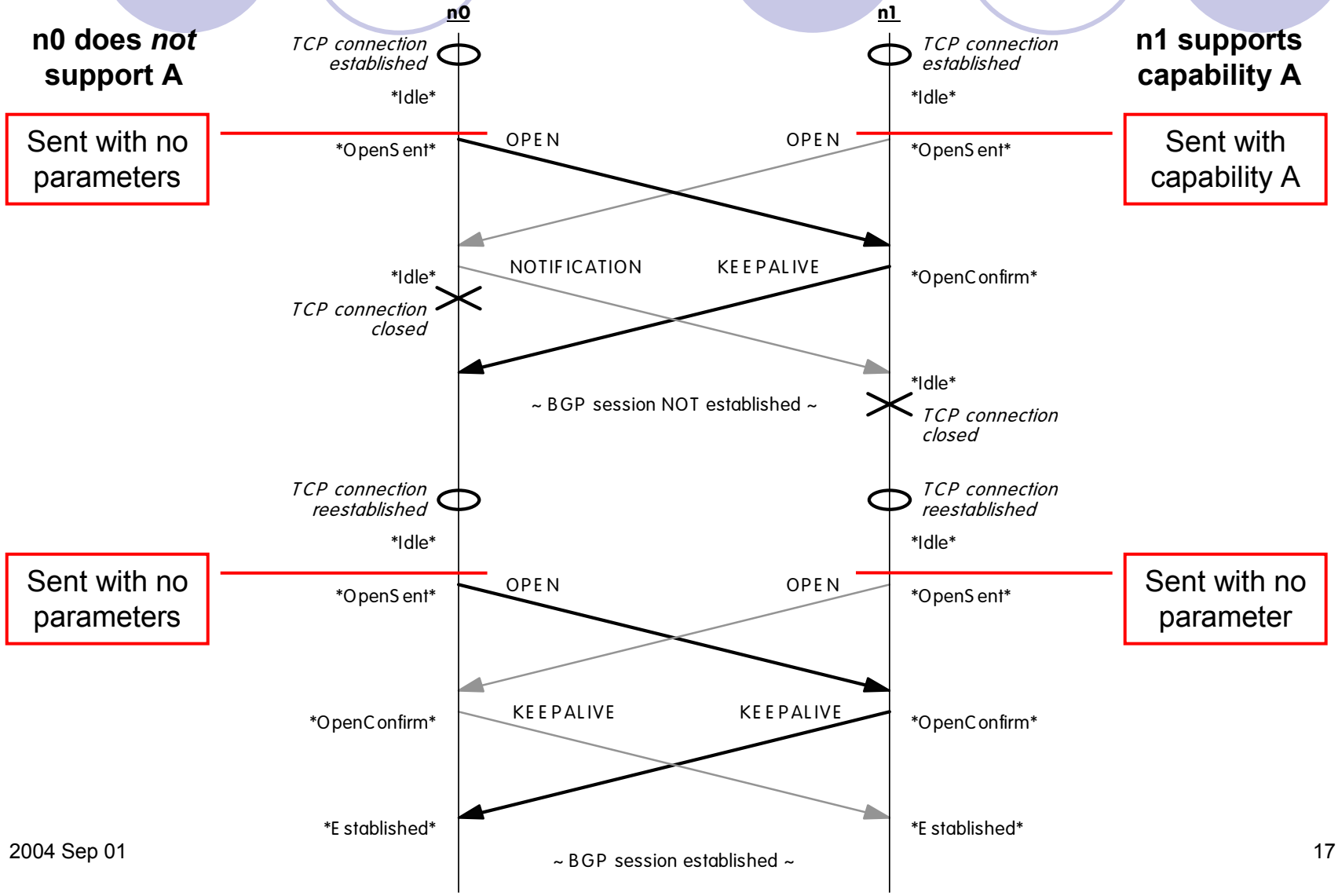
# Contribution: Optional Parameters (cont'd)

- Type 2: Capabilities Advertisement




  - Used to introduce new capabilities into BGP
  - Allows BGP speakers to advertise supported capabilities
  - Negotiated to determine which capabilities to employ during peer session

# Contribution: Negotiation of Parameters

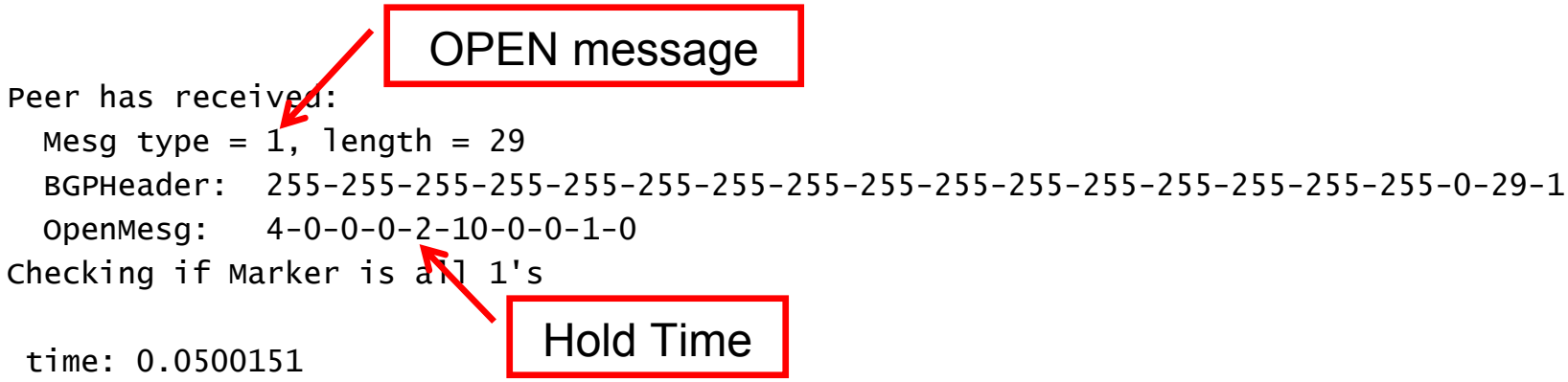


# Simulation Results: Error Checking

- “Unfortunately” the simulator is ideal!
- Data is in fixed structure (object class)
  - Any message sent created directly from object
  - Any message received parsed into an object
- Errors were hard-coded to verify that the error check correctly detected the error
  - Can’t show an entire scenario

# Simulation Results: Error Checking (cont'd)

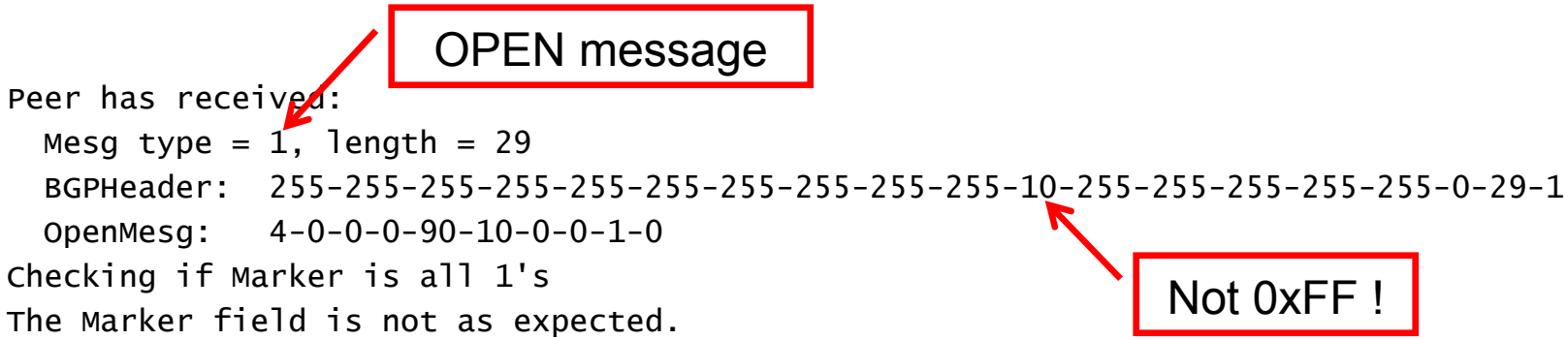
- Hold Time is invalid




```
Peer has received:
  Mesg type = 1, length = 29
  BGPHeader:  255-255-255-255-255-255-255-255-255-255-255-255-255-255-255-255-0-29-1
  OpenMesg:   4-0-0-0-2-10-0-0-1-0
Checking if Marker is all 1's

 time: 0.0500151
 peer return_ip: 10.0.1.1, peer ip_addr: 10.0.0.1
 event_type: *RecvOpen*
 connection_state: *OpenSent*

non-zero Hold Timer value is less than the minimum recommended value 3s
(current_val = 2 s)

 BGP session with peer 10.0.0.1 closed.
```

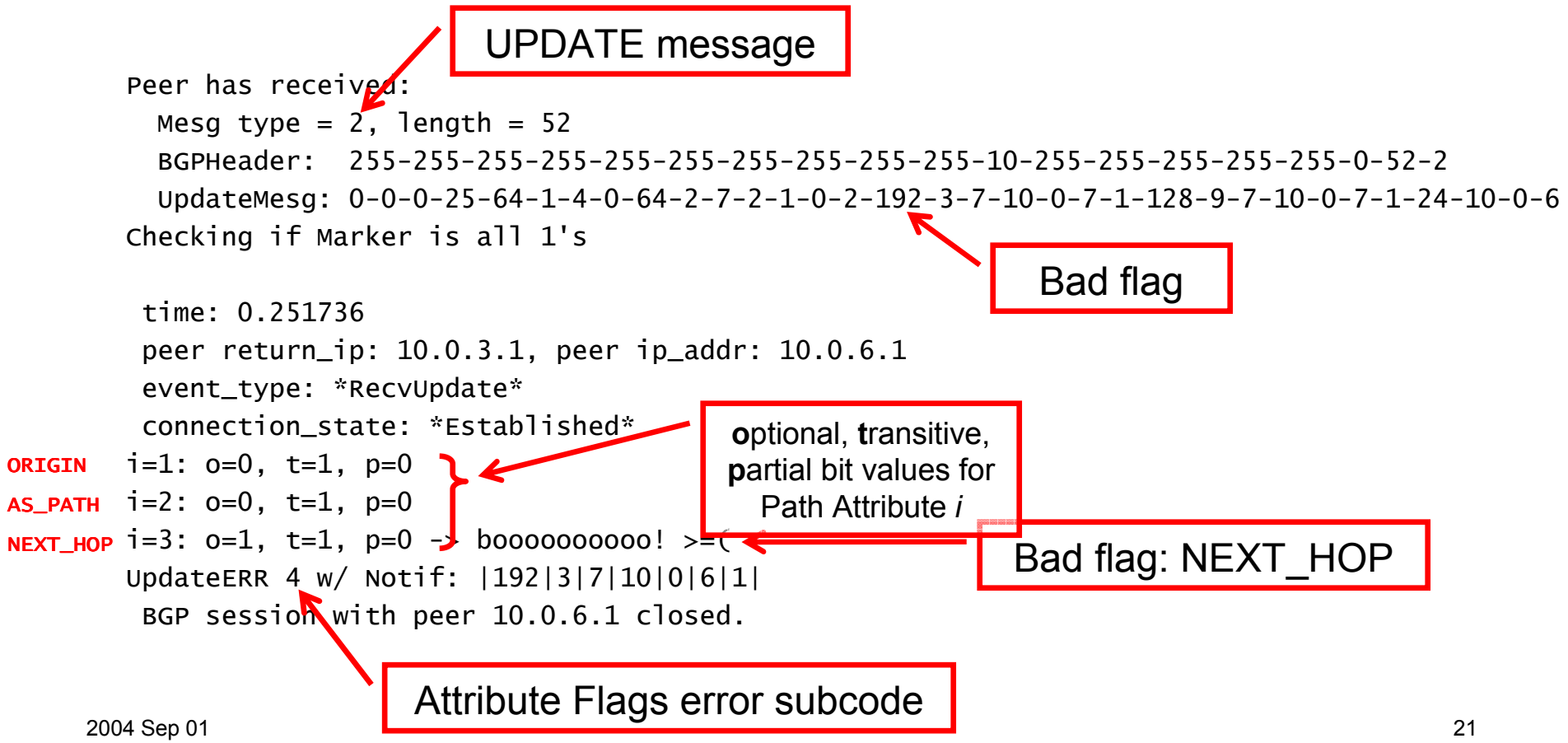
# Simulation Results: Error Checking (cont'd)

- Marker field is invalid



# Simulation Results: Error Checking (cont'd)

- UPDATE Attribute Flags are incorrect



# Simulation Results: Negotiation

- Syntax: [*Auth Code*] / [*Auth Data*]
  - Where [*Auth Data*] is string of characters

- 3 test scenarios:

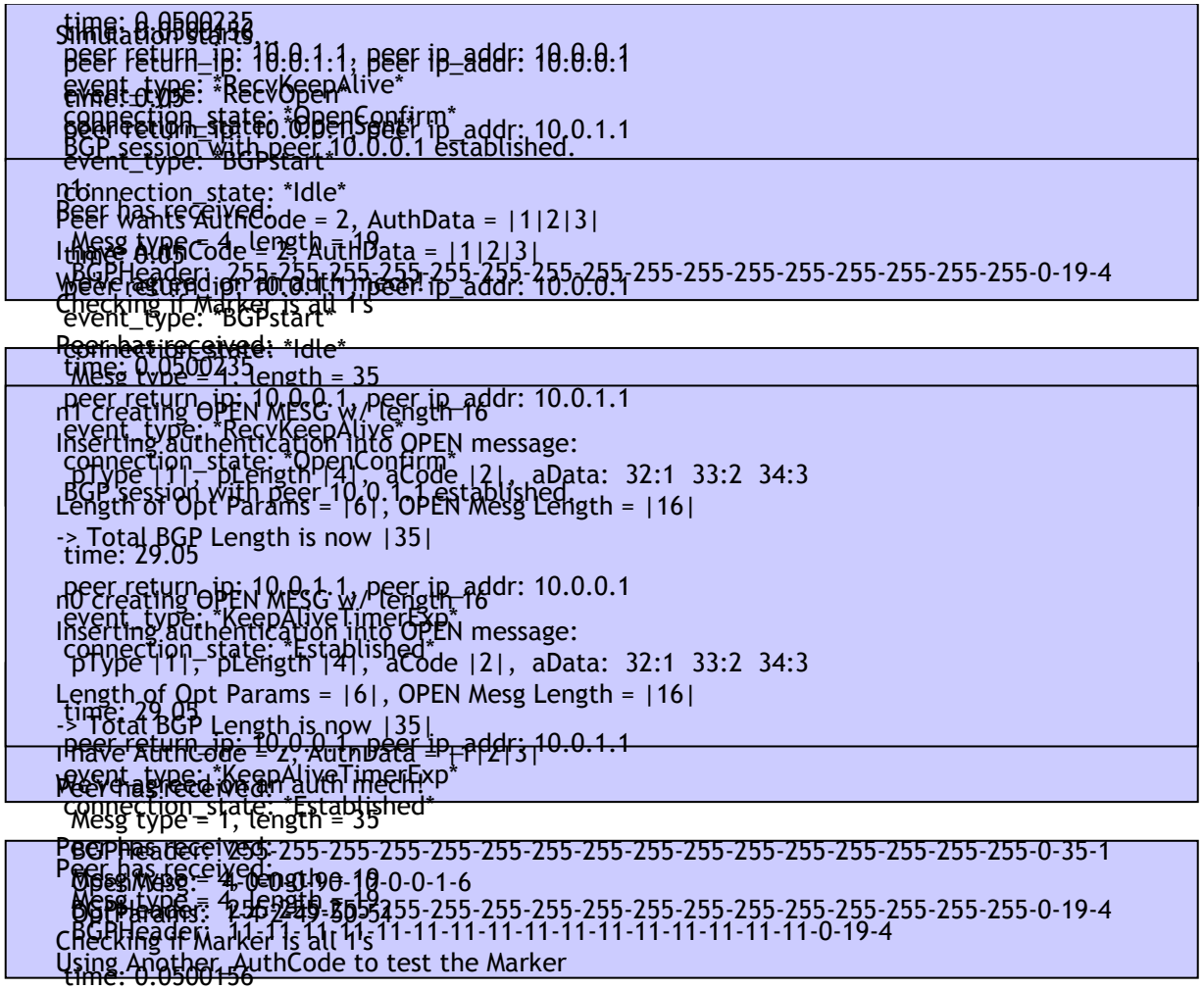
| n0 | n1 | negotiated |
|---|---|---|
| <none> | 2/123 | <none> |
| 2/123 | 2/123 | 2/123 |
| 2/L | 2/123 | <none> |

# Simulation Results: Negotiation (cont'd)

- Scenario 1: n0 supports <none>, n1 supports 2/123

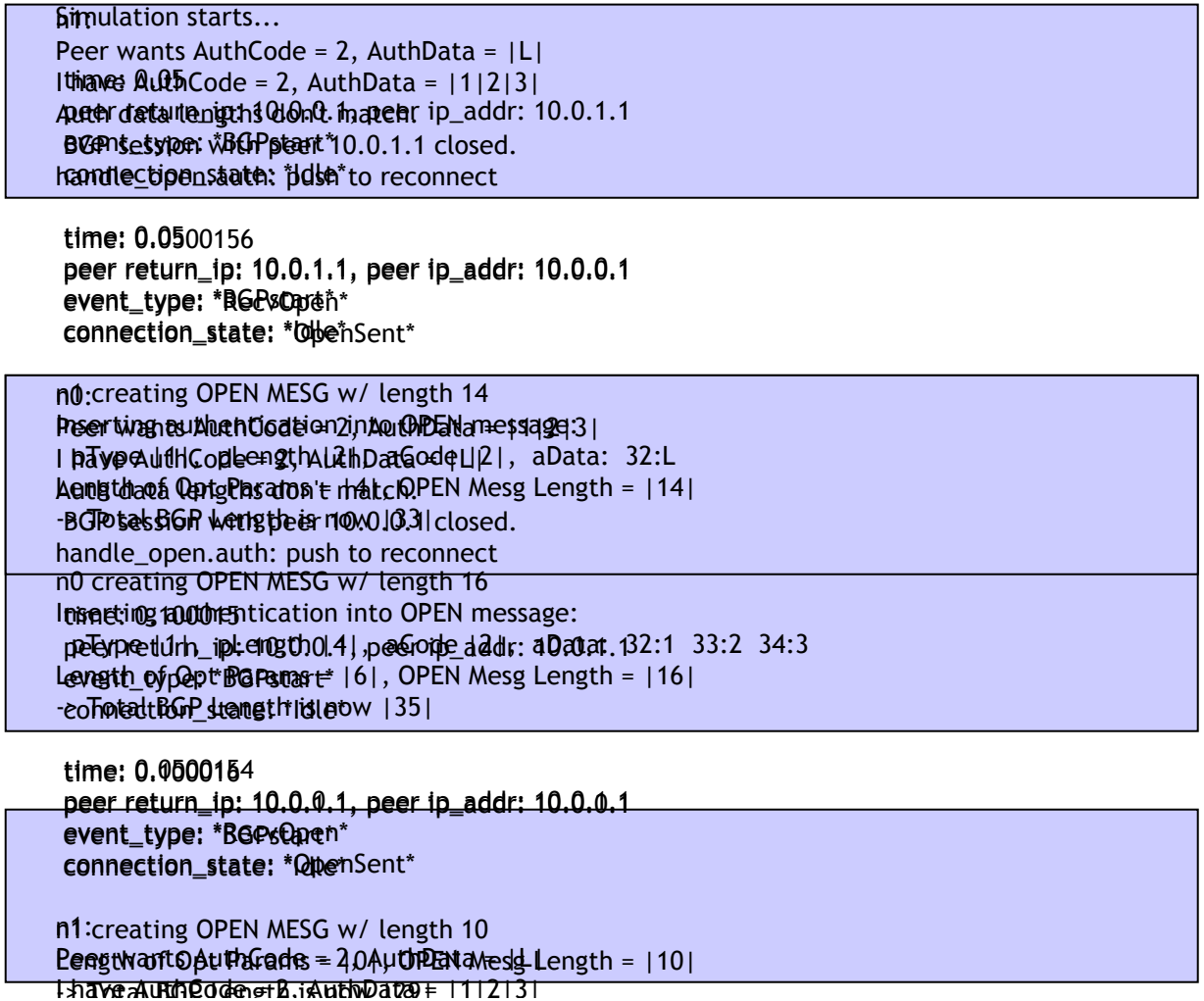
# Simulation Results: Negotiation (cont'd)

- Scenario 2: n0 supports 2/123, n1 supports 2/123



# Simulation Results: Negotiation (cont'd)

- Scenario 3: n0 supports 2/L, n1 supports 2/123



# Simulation Results: Negotiation (cont'd)

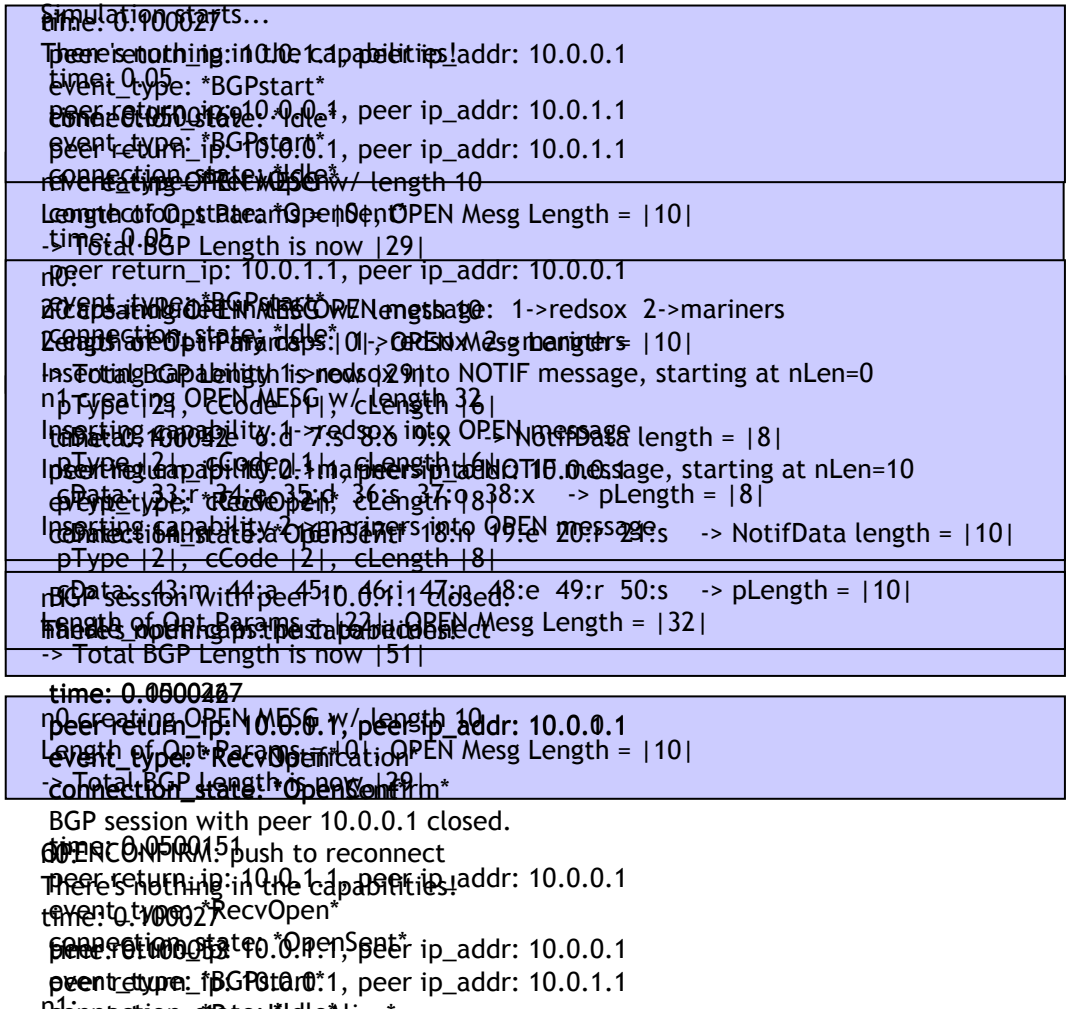
- Syntax: [*Cap Code*] → [*Cap Data*]
  - Where [*Cap Data*] is string of characters

- 2 test scenarios:

| n0 | n1 | negotiated |
|---|---|---|
| <none> | 1→redsox<br>2→mariners | <none> |
| 1→redsox<br>2→mariners | 2→mariners<br>3→angels | 2→mariners |

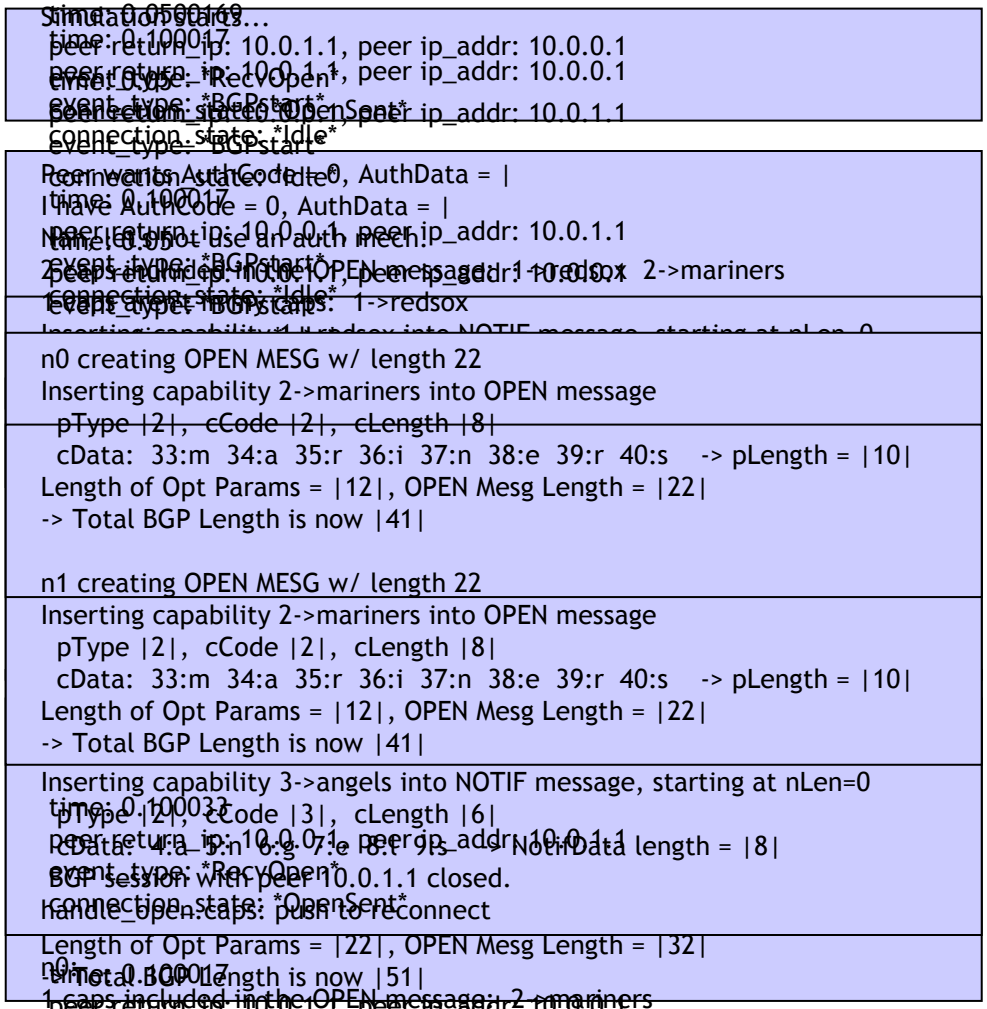
# Simulation Results: Negotiation (cont'd)

- Scenario 4: n0 supports <none>
  n1 supports 1→redsox, 2→mariners



# Simulation Results: Negotiation (cont'd)

- Scenario 5: n0 supports 1→redsox, 2→mariners
  n1 supports 2→mariners, 3→angels



# Future Enhancements

- Restructuring of Optional Parameters
  - Exploit the object-oriented nature of C++
- Handling 0-bytes (NULL character) within Optional Parameter data
- Handling new Capabilities Advertisement
- Handling new Path Attributes

# Conclusion

- Border Gateway Protocol (BGP) is the foremost EGP in use.
- Performance and scalability are of particular interest to the communication networks community.
- To advance the research and development of communication networks in general, simulation tools and network models have been developed, including SSFNet and ns-2.
- The purpose of this project was to expand the capabilities of ns-BGP model. Changes were BGP header and message error checking, and the implementation of and negotiation of optional parameters in the OPEN message.
- These modifications to ns-BGP will ensure that the model grows as the protocol does, with the ability to scale and handle new parameters and capabilities.

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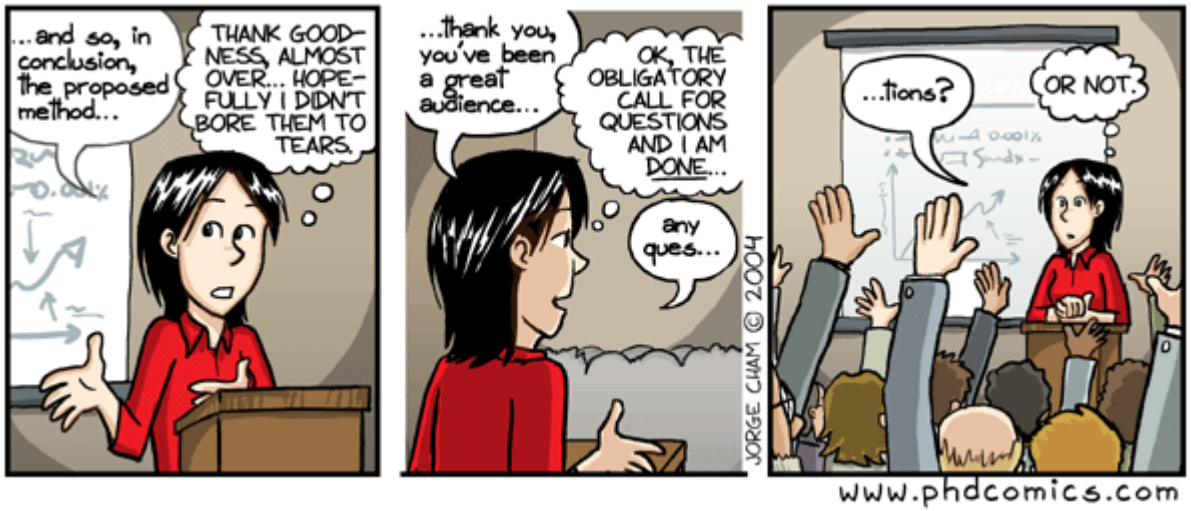
# Questions?

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