Motivation

- Demonstrate the ability to describe OpenFlow via ForCES model.
  - Create an implementatable OpenFlow switch using ForCES architecture
- Facilitate building applications to create either:
  - OpenFlow-enabled ForCES base switch.
  - ForCES-enabled OpenFlow switch.
Current status

- First draft submitted May 25.
- Lots of comments and suggestions.
- Second draft submitted July 9th.
  - Many fixes and updates.
Model draft version 00
Problems with version-00

- Misconceptions from reading the OF specs.
- Queues not correctly placed.
- Model too meshy.
- ActionSet LFB empty.
Changes from version-00

- One OFFlowTables LFB for all Flow Tables within a switch
  - Makes the graph much more simpler.
  - Metadata & ActionSet Metadata’s are now invisible to the model (internal to OFFLowTables).

- ActionSet LFB removed.
  - Original Action Set LFB was empty of components – required data resides in metadata accompanying a packet.
Changes from version-00

- Buffering packets is considered implementation specific and is logically done in the OFFlowTables.
- Added OFRedirectIn & OFRedirectOut.
  - Should these be merged into one? (one point To/From controller)
  - Buffering will be considered to be done in.
- Correctly positioned the OFQueue LFBs and added them to the figure.
Changes from version-00

- Introduced PacketID.
  - Identifier used, by OFFlowTable & OFGroupTable LFBs, to continue processing the packet from where it left (upon returning from an Action LFB).
  - PacketID is opaque to the ActionLFBs and not used by them.
  - PacketID or something similar is necessary, but is it necessary to be modeled, or is it implementation specific?
<table>
<thead>
<tr>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>DatapathID</td>
</tr>
<tr>
<td>MissSendLen</td>
</tr>
<tr>
<td>HandleFragments</td>
</tr>
<tr>
<td>ReassembleFragments</td>
</tr>
<tr>
<td>InvalidTTLtoController</td>
</tr>
<tr>
<td>SwitchDescription</td>
</tr>
<tr>
<td>Ports (Array of {uint32})</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>FlowStatistics</td>
</tr>
<tr>
<td>TableStatistics</td>
</tr>
<tr>
<td>PortStatistics</td>
</tr>
<tr>
<td>GroupStatistics</td>
</tr>
<tr>
<td>IPReassembly</td>
</tr>
<tr>
<td>QueueStats</td>
</tr>
<tr>
<td>ARPMatchIP</td>
</tr>
<tr>
<td>ActionsSupported</td>
</tr>
<tr>
<td>MaxBufferedPackets</td>
</tr>
<tr>
<td>TablesSupported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>PortAdded</td>
</tr>
<tr>
<td>PortDeleted</td>
</tr>
<tr>
<td>PortModified</td>
</tr>
</tbody>
</table>
OfflowTables LFB

**Components**
- FlowTables (array of {array of FlowEntries; FlowCounter; MissBehaviour})
- ApplyActionList (Array of actions)
- WriteActions (Array of actions)
- WriteMetadataTable (Array of Metadata)
- GotoFlowTable (Array of Table indeces)
- GroupTable (Array of Group Table indeces)

**Capabilities**

**Events**
- FlowRemoved
GroupTable LFB

Components
GroupTableEntry (Array of GroupEntries)

GroupEntry:
- GroupID: uint32
- GroupBucketType: uchar
- GroupCounters: struct
- ActionBuckets (Array of {weight;watchport;watchgroup;Actions;BucketCounter})

Capabilities

Events

PacketIn
PacketReturn
PacketOut
ActionPort
Port LFB

Components
GroupTableEntry (PortNumber
IEEEMAC
    Name
    Configuration
    State
    CurrentFeatures
    Advertised
    CurrentSpeed
    MaximumSpeed
    PortCounter

Capabilities
    SupportedFeatures
    AdvertisedFeatures (by peer)

Events
Queue LFB

Components
- QueueID
- Properties (Array of{
  - QueuePropertyType
  - QueueArrayPropertiesType
  - QueueCounterType
})
- QueueCounter

Capabilities

Events
OFAAction LFB

Components

Capabilities

Events

PacketIn

PacketOut
e.g. OFActionSetIPSource

Components
SetIPSourceActionTable (Array of {IPv4Addresses})

Capabilities

Events
### Action LFBs

<table>
<thead>
<tr>
<th>OFActionOutput</th>
<th>OFActionCopyTTLIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFActionSetVLANVID</td>
<td>OFActionSetMPLSLLabel</td>
</tr>
<tr>
<td>OFActionSetVLANPriority</td>
<td>OFActionSetMPLSTC</td>
</tr>
<tr>
<td>OFActionSetMACSource</td>
<td>OFActionSetMPLSTTL</td>
</tr>
<tr>
<td>OFActionSetMACDestination</td>
<td>OFActionDecrementMPLSTTL</td>
</tr>
<tr>
<td>OFActionSetIPSource</td>
<td>OFActionPushVLAN</td>
</tr>
<tr>
<td>OFActionSetIPDestination</td>
<td>OFActionPopVLAN</td>
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<tr>
<td>OFActionSetIPTOS</td>
<td>OFActionPushMPLS</td>
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<tr>
<td>OFActionSetIPECN</td>
<td>OFActionPopMPLS</td>
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<td>OFActionSetTCPSource</td>
<td>OFActionSetQueue</td>
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<tr>
<td>OFActionSetTCPDestination</td>
<td>OFActionSetIPTTL</td>
</tr>
<tr>
<td>OFActionCopyTTLOut</td>
<td>OFActionDecrementIPTTL</td>
</tr>
</tbody>
</table>
Future Plans

- Finalize the XML by next draft after comments and answered questions.
- Add OpenFlow 1.0, 1.2 and 1.3 libraries.
Backup Slide #1

ForCES Controller (CE)

ForCES Protocol

ForCES Wrapper

LFB description

Open vSwitch 1.4 + Extension (OpenFlow v1.0)