Specific or universal Beacons?

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Please see https://mentor.ieee.org/ for the original version in PowerPoint format.

Outline

- **802.11 Beacons reviewed**
  - Structure
  - Frame body contents
  - Examples Calculations
  - Future Information Elements
  - Measurements
- **Concept: „Mesh-only“ beacon**
  - Pros & Cons
- **Conlusions**

Management frame format

- **Frame Type (Beacon frame) = Management**
- **Management frame format**

	Min size (octet)	Max size (octet)
Frame Control	2	2
Duration	2	2
DA	6	6
SA	6	6
Sequence Control	2	2
Frame Body	0	2312
FCS	4	4

Beacon: Frame body contents (1-13)

Information	Notes	Mandatory	Size (octets)
Timestamp		yes	8
Beacon interval		yes	2
Capability		yes	2
Service Set Identifier (SSID)		yes	2-34
Supported rates		yes	3-10
Frequency-Hopping (FH) Parameter Set	The FH Parameter Set information element is present within Beacon frames generated by STAs using FH PHYs.	yes/no	7
DS Parameter Set	The DS Parameter Set information element is present within Beacon frames generated by STAs using Clause 15, Clause 18, and Clause 19 PHYs.	yes/no	3
CF Parameter Set	The CF Parameter Set information element is present only within Beacon frames generated by APs supporting a point coordina-tion function (PCF).	yes/no	8
IBSS Parameter Set	The IBSS Parameter Set information element is present only within Beacon frames generated by STAs in an IBSS.	yes/no	4
Traffic indication map (TIM)	The TIM information element is present only within Beacon frames generated by APs.	yes/no	6-256
Country	The Country information element shall be present when dot11MultiDomainCapabilityEnabled is true or dot11SpectrumManagementRequired is true.	yes/no	8 - 256
FH Parameters	FH Parameters as specified in 7.3.2.10 may be included if dot11MultiDomainCapabilityEnabled is true.	no	4
FH Pattern Table	FH Pattern Table information as specified in 7.3.2.11 may be included if dot11MultiDomainCapabilityEnabled is true.	no	6 - 256

Beacon: Frame body contents (14-21)

Order	Information	Notes	Mandatory	Size (octets)
14	Power Constraint	Power Constraint element shall be present if dot11SpectrumManagementRequired is true.	yes/no	3
15	Channel Switch Announcement	Channel Switch Announcement element may be present if dot11SpectrumManagementRequired is true.	no	5
16	Quiet	Quiet element may be present if dot11SpectrumManagementRequired is true.	no	8
17	IBSS DFS	IBSS DFS element shall be present if dot11SpectrumManagementRequired is true in an IBSS.	yes/no	10 - 255
18	TPC Report	TPC Report element shall be present if dot11SpectrumManagementRequired is true.	yes/no	4
19	ERP Information	The ERP Information element is present within Beacon frames generated by STAs using extended rate PHYs (ERPs) defined in Clause 19 and is optionally present in other cases.	yes/no	3
20	Extended Supported Rates	The Extended Supported Rates element is present whenever there are more than eight supported rates, and it is optional otherwise.	yes/no	3 - 257
21	RSN	The RSN information element shall be present within Beacon frames generated by STAs that have dot11RSNAEnabled set to TRUE	yes/no	36 - 256

Beacon: Frame body contents (22-24 & 256)

Order	Information	Notes	Mandatory	Size (octets)
22	BSS Load	The BSS Load element is present when dot11QosOption-Implemented and dot11QBSSLoadImplemented are both true.	yes/no	7
23	EDCA Parameter Set	The EDCA Parameter Set element is present when dot11QosOptionImplemented is true and the QoS Capability element is not present.	yes/no	20
24	QoS Capability	The QoS Capability element is present when dot11Qos-OptionImplemented is true and EDCA Parameter Set element is not present.	yes/no	3
Last	Vendor Specific	One or more vendor-specific information elements may appear in this frame. This information element follows all other information elements.	no	3 - 257

Example calculation (1)

- **Assume minimal functionality beacon**
  - 802.11a/g OFDM PHY
- **Minimum**
  - 26 B
- **Maximum**
  - 569 B
- **Typical**
  - Depends on Power saving stations

Information	Size (octets)
Timestamp	8
Beacon interval	2
Capability	2
Service Set Identifier (SSID)	2-34
Supported rates	3-10
Traffic indication map	6-256
Extended Supported Rates	3-257

Example calculation (2)

- **Assume non-US AP location**
  - 802.11a/g OFDM PHY, DFS & TPC required
- **Minimum**
  - 54 B
- **Maximum**
  - 845 B
- **Typical**
  - Depends on Power saving stations

Information	Size (octets)
Timestamp	8
Beacon interval	2
Capability	2
Service Set Identifier (SSID)	2-34
Supported rates	3-10
Traffic indication map (TIM)	6-256
Country	8-256
Extended Supported Rates	3-257
Power Constraint	3
Channel Switch Announcement	5
Quiet	8
TPC Report	4

Example calculation (3)

- **Assume non-US QAP location**
  - 802.11a/g OFDM PHY, DFS & TPC required, BSS Load, EDCA parameter set announced
- **Minimum**
  - 81B
- **Maximum**
  - 872B
- **Typical**
  - Depends on Power saving stations

Information	Size (octets)
Timestamp	8
Beacon interval	2
Capability	2
Service Set Identifier (SSID)	2-34
Supported rates	3-10
Traffic indication map (TIM)	6-256
Country	8-256
Extended Supported Rates	3-257
Power Constraint	3
Channel Switch Announcement	5
Quiet	8
TPC Report	4
BSS Load	7
EDCA Parameter Set	20

802.11k

- **AP Channel Report**
  - 3-257B
- **BSS Average Access Delay**
  - 3B
- **Antenna Information**
  - 3B
- **BSS Available Admission Capacity**
  - 4-28B
- **BSS AC Access Delay**
  - 6B

802.11r

- **Mobility Domain Information**
  - 9 B
- **NAS-ID**
  - 3-257 (?)

802.11u

- **Interworking Capability**
  - 4B
- **Generic Advertisement Service Capability**
  - 2-257B (?)
- **Generic Advertising Service Traffic Indication Map**
  - 6-257B
- **ESSID**
  - 8B
- **Default Emergency Services Realm**
  - 2-257B (?)

No.	Time	Source	Destination	Protocol	Info
1	0.000000	SmcNetwo_66:	Broadcast	IEEE 8	Beacon frame, SN=1393, FN=0, BI=100, SSID:
2	0.264118	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=678, FN=0, BI=100, SSID:
3	0.468956	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=686, FN=0, BI=100, SSID:
4	0.571374	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=687, FN=0, BI=100, SSID:
5	0.673787	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=689, FN=0, BI=100, SSID:
6	0.776193	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=692, FN=0, BI=100, SSID:
7	0.878608	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=694, FN=0, BI=100, SSID:
8	0.981010	AlphaNet_11:	Broadcast	IEEE 8	Beacon frame, SN=696, FN=0, BI=100, SSID:

```
⊞ Frame 1 (61 bytes on wire, 61 bytes captured)
⊞ IEEE 802.11
⊟ IEEE 802.11 wireless LAN management frame
  ⊟ Fixed parameters (12 bytes)
      Timestamp: 0x0000000126146121
      Beacon Interval: 0,102400 [Seconds]
    ⊟ Capability Information: 0x0041
        .... .... .... ...1 = ESS capabilities: Transmitter is an AP
        .... .... .... ..0. = IBSS status: Transmitter belongs to a BSS
        .... ..0. .... 00.. = CFP participation capabilities: No point coordinator at AP (0x0000)
        .... .... ...0 .... = Privacy: AP/STA cannot support WEP
        .... .... ..0. .... = Short Preamble: Short preamble not allowed
        .... .... .1.. .... = PBCC: PBCC modulation allowed
        .... .... 0... .... = Channel Agility: Channel agility not in use
        .... ...0 .... .... = Spectrum Management: dot11SpectrumManagementRequired FALSE
        .... .0.. .... .... = Short Slot Time: Short slot time not in use
        .... 0... .... .... = Automatic Power Save Delivery: apsd not implemented
        ..0. .... .... .... = DSSS-OFDM: DSSS-OFDM modulation not allowed
        .0.. .... .... .... = Delayed Block Ack: delayed block ack not implented
        0... .... .... .... = Immediate Block Ack: immediate block ack not implented
  ⊟ Tagged parameters (25 bytes)
    ⊟ SSID parameter set: "[redacted]"
        Tag Number: 0 (SSID parameter set)
        Tag length: 7
        Tag interpretation: [redacted]
    ⊟ Supported Rates: 1,0(B) 2,0(B) 5,5(B) 11,0(B) 22,0
        Tag Number: 1 (Supported Rates)
        Tag length: 5
        Tag interpretation: Supported rates: 1,0(B) 2,0(B) 5,5(B) 11,0(B) 22,0  [Mbit/sec]
    ⊟ DS Parameter set: Current Channel: 1
        Tag Number: 3 (DS Parameter set)
        Tag length: 1
        Tag interpretation: Current Channel: 1
    ⊟ (TIM) Traffic Indication Map: DTIM 1 of 3 bitmap empty
        Tag Number: 5 ((TIM) Traffic Indication Map)
        TIM length: 4
        DTIM count: 1
        DTIM period: 3
        Bitmap Control: 0x00 (mcast:0, bitmap offset 0)
```

Beacon from 802.11b AP

No.	Time	Source	Destination	Protocol	Info
1	0.000000	SmcNetwo_66	Broadcast	IEEE 8	Beacon frame, SN=1393, FN=0, BI=100, SSID:
2	0.264118	AlphaNet_11	Broadcast	IEEE 8	Beacon frame, SN=678, FN=0, BI=100, SSID:

```
⊞ Frame 2 (129 bytes on wire, 129 bytes captured)
⊞ IEEE 802.11
⊟ IEEE 802.11 wireless LAN management frame
  ⊟ Fixed parameters (12 bytes)
      Timestamp: 0x00000128F0842181
      Beacon Interval: 0,102400 [Seconds]
    ⊞ Capability Information: 0x0021
  ⊟ Tagged parameters (93 bytes)
    ⊟ SSID parameter set: "    "
        Tag Number: 0 (SSID parameter set)
        Tag length: 4
        Tag interpretation:
    ⊟ Supported Rates: 1,0(B) 2,0(B) 5,5 11,0
        Tag Number: 1 (Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 1,0(B) 2,0(B) 5,5 11,0  [Mbit/sec]
    ⊟ DS Parameter set: Current Channel: 6
        Tag Number: 3 (DS Parameter set)
        Tag length: 1
        Tag interpretation: Current Channel: 6
    ⊟ (TIM) Traffic Indication Map: DTIM 0 of 1 bitmap empty
        Tag Number: 5 ((TIM) Traffic Indication Map)
        TIM length: 4
        DTIM count: 0
        DTIM period: 1
        Bitmap Control: 0x00 (mcast:0, bitmap offset 0)
    ⊟ Country Information: Country Code: DE, Any Environment
        Tag Number: 7 (Country Information)
        Tag length: 6
        Tag interpretation: Country Code: DE, Any Environment
          Start Channel: 1, Channels: 13, Max TX Power: 18 dBm
    ⊟ ERP Information: Non-ERP STAs, use protection, long preambles
        Tag Number: 42 (ERP Information)
        Tag length: 1
        Tag interpretation: ERP info: 0x3 (Non-ERP STAs, use protection, long preambles)
    ⊟ Extended Supported Rates: 6,0 9,0 12,0 18,0 24,0 36,0 48,0 54,0
        Tag Number: 50 (Extended Supported Rates)
        Tag length: 8
        Tag interpretation: Supported rates: 6,0 9,0 12,0 18,0 24,0 36,0 48,0 54,0  [Mbit/sec]
    ⊟ Vendor Specific: AtherosC
        Tag Number: 221 (Vendor Specific)
        Tag length: 9
        Vendor: AtherosC
        Tag interpretation: Not interpreted
    ⊞ Cisco Unknown 1 + Device Name
    ⊞ Agere Proprietary: Tag 128 Len 6
```

Beacon from 802.11b/g AP

No.	Time	Source	Destination	Protocol	Info
33	5.794419	AlphaNet_11	Broadcast	IEEE 8	Beacon frame, SN=831, FN=0, BI=100, SSID:
34	6.370393	Private_02:	Broadcast	IEEE 8	Beacon frame, SN=2854, FN=0, BI=100, SSID:
35	6.575344	Private_02:	Broadcast	IEEE 8	Beacon frame, SN=2856, FN=0, BI=100, SSID:

```
⊞ Frame 34 (96 bytes on wire, 96 bytes captured)
⊞ IEEE 802.11
⊟ IEEE 802.11 wireless LAN management frame
  ⊟ Fixed parameters (12 bytes)
      Timestamp: 0x00000000F318D211
      Beacon Interval: 0,102400 [Seconds]
    ⊟ Capability Information: 0x0002
        .... .... .... ...0 = ESS capabilities: Transmitter is a STA
        .... .... .... ..1. = IBSS status: Transmitter belongs to an IBSS
        .... ..0. .... 00.. = CFP participation capabilities: Station is not CF-Pollable (0x0000)
        .... .... ...0 .... = Privacy: AP/STA cannot support WEP
        .... .... ..0. .... = Short Preamble: Short preamble not allowed
        .... .... .0.. .... = PBCC: PBCC modulation not allowed
        .... .... 0... .... = Channel Agility: Channel agility not in use
        .... ...0 .... .... = Spectrum Management: dot11SpectrumManagementRequired FALSE
        .... .0.. .... .... = Short Slot Time: Short slot time not in use
        .... 0... .... .... = Automatic Power Save Delivery: apsd not implemented
        ..0. .... .... .... = DSSS-OFDM: DSSS-OFDM modulation not allowed
        .0.. .... .... .... = Delayed Block Ack: delayed block ack not implented
        0... .... .... .... = Immediate Block Ack: immediate block ack not implented
  ⊟ Tagged parameters (60 bytes)
    ⊟ SSID parameter set: "[redacted]"
        Tag Number: 0 (SSID parameter set)
        Tag length: 18
        Tag interpretation: [redacted]
    ⊟ Supported Rates: 1,0(B) 2,0(B) 5,5(B) 11,0(B) 18,0 24,0 36,0 54,0
        Tag Number: 1 (Supported Rates)
        Tag length: 8
        Tag interpretation: Supported rates: 1,0(B) 2,0(B) 5,5(B) 11,0(B) 18,0 24,0 36,0 54,0  [Mbit/sec]
    ⊟ DS Parameter set: Current Channel: 11
        Tag Number: 3 (DS Parameter set)
        Tag length: 1
        Tag interpretation: Current Channel: 11
    ⊟ IBSS Parameter set: ATIM window 0x0
        Tag Number: 6 (IBSS Parameter set)
        Tag length: 2
        Tag interpretation: ATIM window 0x0
    ⊞ ERP Information: no Non-ERP STAs, do not use protection, long preambles
    ⊞ ERP Information: no Non-ERP STAs, do not use protection, long preambles
    ⊟ Extended Supported Rates: 6,0 9,0 12,0 48,0
        Tag Number: 50 (Extended Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 6,0 9,0 12,0 48,0  [Mbit/sec]
    ⊞ Vendor Specific: Broadcom
```

Beacon from 802.11b/g STA (IBSS)

No.	Time	Source	Destination	Protocol	Info
1	0.000000	Cisco_fc:5c:92	Broadcast	IEEE 8	Beacon frame,SN=3726,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
2	0.295245	Netgear_89:90:93	Ibm_22:18:f0	LLC	I, N(R)=85, N(S)=85; DSAP 0xc0 Individual, SSAP NULL LSAP Command
3	0.914889	IntelCor_b9:a5:be	Cisco_fc:45:40	IEEE 8	QoS Null function (No data),SN=3773,FN=0
4	1.338796	Cisco_fc:3e:12	Broadcast	IEEE 8	Beacon frame,SN=3406,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
5	1.341179	Cisco_83:b0:32	Broadcast	IEEE 8	Beacon frame,SN=3479,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
6	1.343179	Cisco_83:c8:a1	Broadcast	IEEE 8	Beacon frame,SN=3845,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
7	1.355737	Intel_1c:8e:7e	Ibm_49:a5:78	LLC	I, N(R)=85, N(S)=85; DSAP NULL LSAP Individual, SSAP NULL LSAP Command
8	1.359484	Ibm_49:a5:78	HewlettP_80:52:10	IEEE 8	QoS Data,SN=1145,FN=0
9	1.365286	Cisco_83:b2:12	Broadcast	IEEE 8	Beacon frame,SN=2012,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
10	1.367076	Cisco_83:b0:31	Broadcast	IEEE 8	Beacon frame,SN=3484,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
11	1.370954	Ibm_49:a5:78	HewlettP_80:52:10	IEEE 8	QoS Data,SN=1148,FN=0
12	1.372716	Cisco_fc:3e:11	Broadcast	IEEE 8	Beacon frame,SN=3407,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
13	1.373183	Cisco_83:a7:b1	Broadcast	IEEE 8	Beacon frame,SN=3959,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
14	1.375911	Cisco_83:c8:a0	Broadcast	IEEE 8	Beacon frame,SN=3848,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]
15	1.400539	Cisco_83:b0:30	Broadcast	IEEE 8	Beacon frame,SN=3485,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]
16	1.434033	Cisco_83:b2:10	Broadcast	IEEE 8	Beacon frame,SN=2017,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]

```
⊟ Frame 1 (210 bytes on wire, 152 bytes captured)
    Arrival Time: Mar 12, 2007 18:50:26.006004999
    [Time delta from previous packet: 0.000000000 seconds]
    [Time since reference or first frame: 0.000000000 seconds]
    Frame Number: 1
    Packet Length: 210 bytes
    Capture Length: 152 bytes
    [Protocols in frame: wlan]
⊟ IEEE 802.11
    Data Rate: 11.0 Mb/s
    Channel: 1
    Signal Strength: 70%
    Type/Subtype: Beacon frame (8)
  ⊞ Frame Control: 0x0080 (Normal)
    Duration: 0
    Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
    Source address: Cisco_fc:5c:92 (00:15:c7:fc:5c:92)
    BSS Id: Cisco_fc:5c:92 (00:15:c7:fc:5c:92)
    Fragment number: 0
    Sequence number: 3726
⊟ IEEE 802.11 wireless LAN management frame
  ⊞ Fixed parameters (12 bytes)
  ⊟ Tagged parameters (174 bytes)
    ⊞ SSID parameter set: "\000"
    ⊞ Supported Rates: 5,5 6,0 9,0 11,0(B) 12,0 18,0 24,0 36,0
    ⊞ DS Parameter set: Current Channel: 1
    ⊞ (TIM) Traffic Indication Map: DTIM 1 of 2 bitmap empty
    ⊞ ERP Information: Non-ERP STAs, use protection, short or long preambles
    ⊞ RSN Information
    ⊞ Vendor Specific: WPA
    ⊞ Extended Supported Rates: 48,0 54,0
    ⊞ Cisco Unknown 1 + Device Name
    ⊞ Vendor Specific
```

IEEE beacon (SSID: \000)

No.	Time	Source	Destination	Protocol	Info
1	0.000000	Cisco_fc:5c:92	Broadcast	IEEE 8	Beacon frame,SN=3726,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
2	0.295245	Netgear_89:90:93	Ibm_22:18:f0	LLC	I, N(R)=85, N(S)=85; DSAP 0xc0 Individual, SSAP NULL LSAP Command
3	0.914889	IntelCor_b9:a5:be	Cisco_fc:45:40	IEEE 8	QoS Null function (No data),SN=3773,FN=0
4	1.338796	Cisco_fc:3e:12	Broadcast	IEEE 8	Beacon frame,SN=3406,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
5	1.341179	Cisco_83:b0:32	Broadcast	IEEE 8	Beacon frame,SN=3479,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
6	1.343179	Cisco_83:c8:a1	Broadcast	IEEE 8	Beacon frame,SN=3845,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
7	1.355737	Intel_1c:8e:7e	Ibm_49:a5:78	LLC	I, N(R)=85, N(S)=85; DSAP NULL LSAP Individual, SSAP NULL LSAP Command
8	1.359484	Ibm_49:a5:78	HewlettP_80:52:10	IEEE 8	QoS Data,SN=1145,FN=0
9	1.365286	Cisco_83:b2:12	Broadcast	IEEE 8	Beacon frame,SN=2012,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
10	1.367076	Cisco_83:b0:31	Broadcast	IEEE 8	Beacon frame,SN=3484,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
11	1.370954	Ibm_49:a5:78	HewlettP_80:52:10	IEEE 8	QoS Data,SN=1148,FN=0
12	1.372716	Cisco_fc:3e:11	Broadcast	IEEE 8	Beacon frame,SN=3407,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
13	1.373183	Cisco_83:a7:b1	Broadcast	IEEE 8	Beacon frame,SN=3959,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
14	1.375911	Cisco_83:c8:a0	Broadcast	IEEE 8	Beacon frame,SN=3848,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]
15	1.400539	Cisco_83:b0:30	Broadcast	IEEE 8	Beacon frame,SN=3485,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]

```
⊟ Frame 14 (165 bytes on wire, 152 bytes captured)
    Arrival Time: Mar 12, 2007 18:50:27.381915999
    [Time delta from previous packet: 0.002728000 seconds]
    [Time since reference or first frame: 1.375911000 seconds]
    Frame Number: 14
    Packet Length: 165 bytes
    Capture Length: 152 bytes
    [Protocols in frame: wlan]
⊟ IEEE 802.11
    Data Rate: 11.0 Mb/s
    Channel: 6
    Signal Strength: 48%
    Type/Subtype: Beacon frame (8)
  ⊞ Frame Control: 0x0080 (Normal)
    Duration: 0
    Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
    Source address: Cisco_83:c8:a0 (00:15:c7:83:c8:a0)
    BSS Id: Cisco_83:c8:a0 (00:15:c7:83:c8:a0)
    Fragment number: 0
    Sequence number: 3848
⊟ IEEE 802.11 wireless LAN management frame
  ⊞ Fixed parameters (12 bytes)
  ⊟ Tagged parameters (129 bytes)
    ⊞ SSID parameter set: "IEEE"
    ⊞ Supported Rates: 5,5 6,0 9,0 11,0(B) 12,0 18,0 24,0 36,0
    ⊞ DS Parameter set: Current Channel: 6
    ⊞ (TIM) Traffic Indication Map: DTIM 0 of 2 bitmap mcast 60
    ⊞ ERP Information: Non-ERP STAs, use protection, long preambles
    ⊞ Extended Supported Rates: 48,0 54,0
    ⊞ Cisco Unknown 1 + Device Name
    ⊞ Vendor Specific: Aironet Unknown
    ⊞ Vendor Specific: Aironet CCX version = 3
    ⊞ Vendor Specific: Aironet Qos
    ⊞ Vendor Specific
```

IEEE beacon (SSID: IEEE)

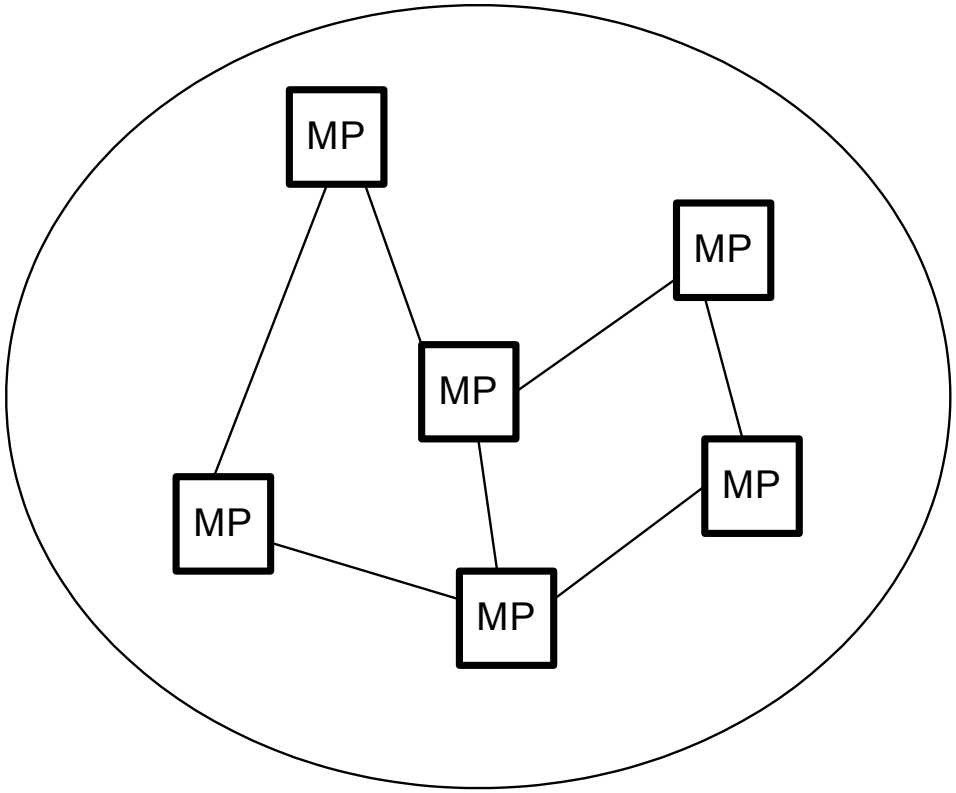
No.	Time	Source	Destination	Protocol	Info
1	0.000000	Cisco_fc:5c:92	Broadcast	IEEE 8	Beacon frame,SN=3726,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
2	0.295245	Netgear_89:90:93	Ibm_22:18:f0	LLC	I, N(R)=85, N(S)=85; DSAP 0xc0 Individual, SSAP NULL LSAP Command
3	0.914889	IntelCor_b9:a5:be	Cisco_fc:45:40	IEEE 8	QoS Null function (No data),SN=3773,FN=0
4	1.338796	Cisco_fc:3e:12	Broadcast	IEEE 8	Beacon frame,SN=3406,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
5	1.341179	Cisco_83:b0:32	Broadcast	IEEE 8	Beacon frame,SN=3479,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
6	1.343179	Cisco_83:c8:a1	Broadcast	IEEE 8	Beacon frame,SN=3845,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
7	1.355737	Intel_1c:8e:7e	Ibm_49:a5:78	LLC	I, N(R)=85, N(S)=85; DSAP NULL LSAP Individual, SSAP NULL LSAP Command
8	1.359484	Ibm_49:a5:78	HewlettP_80:52:10	IEEE 8	QoS Data,SN=1145,FN=0
9	1.365286	Cisco_83:b2:12	Broadcast	IEEE 8	Beacon frame,SN=2012,FN=0,BI=100, SSID: "\000", Name: "ap"[Packet size limited during capture]
10	1.367076	Cisco_83:b0:31	Broadcast	IEEE 8	Beacon frame,SN=3484,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
11	1.370954	Ibm_49:a5:78	HewlettP_80:52:10	IEEE 8	QoS Data,SN=1148,FN=0
12	1.372716	Cisco_fc:3e:11	Broadcast	IEEE 8	Beacon frame,SN=3407,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
13	1.373183	Cisco_83:a7:b1	Broadcast	IEEE 8	Beacon frame,SN=3959,FN=0,BI=100, SSID: "IEEE.1x", Name: "ap"[Packet size limited during capture]
14	1.375911	Cisco_83:c8:a0	Broadcast	IEEE 8	Beacon frame,SN=3848,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]
15	1.400539	Cisco_83:b0:30	Broadcast	IEEE 8	Beacon frame,SN=3485,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]
16	1.434033	Cisco_83:b2:10	Broadcast	IEEE 8	Beacon frame,SN=2017,FN=0,BI=100, SSID: "IEEE", Name: "ap"[Packet size limited during capture]

```
⊟ Frame 6 (220 bytes on wire, 152 bytes captured)
    Arrival Time: Mar 12, 2007 18:50:27.349183999
    [Time delta from previous packet: 0.002000000 seconds]
    [Time since reference or first frame: 1.343179000 seconds]
    Frame Number: 6
    Packet Length: 220 bytes
    Capture Length: 152 bytes
    [Protocols in frame: wlan]
⊟ IEEE 802.11
    Data Rate: 11.0 Mb/s
    Channel: 6
    Signal Strength: 40%
    Type/Subtype: Beacon frame (8)
  ⊞ Frame Control: 0x0080 (Normal)
    Duration: 0
    Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
    Source address: Cisco_83:c8:a1 (00:15:c7:83:c8:a1)
    BSS Id: Cisco_83:c8:a1 (00:15:c7:83:c8:a1)
    Fragment number: 0
    Sequence number: 3845
⊟ IEEE 802.11 wireless LAN management frame
  ⊞ Fixed parameters (12 bytes)
  ⊟ Tagged parameters (184 bytes)
    ⊞ SSID parameter set: "IEEE.1x"
    ⊞ Supported Rates: 5,5 6,0 9,0 11,0(B) 12,0 18,0 24,0 36,0
    ⊞ DS Parameter set: Current Channel: 6
    ⊞ (TIM) Traffic Indication Map: DTIM 1 of 2 bitmap 52 76
    ⊞ ERP Information: Non-ERP STAs, use protection, long preambles
    ⊞ RSN Information
    ⊞ Vendor Specific: WPA
    ⊞ Extended Supported Rates: 48,0 54,0
    ⊞ Cisco Unknown 1 + Device Name
```

IEEE beacon (SSID: IEEE.1x)

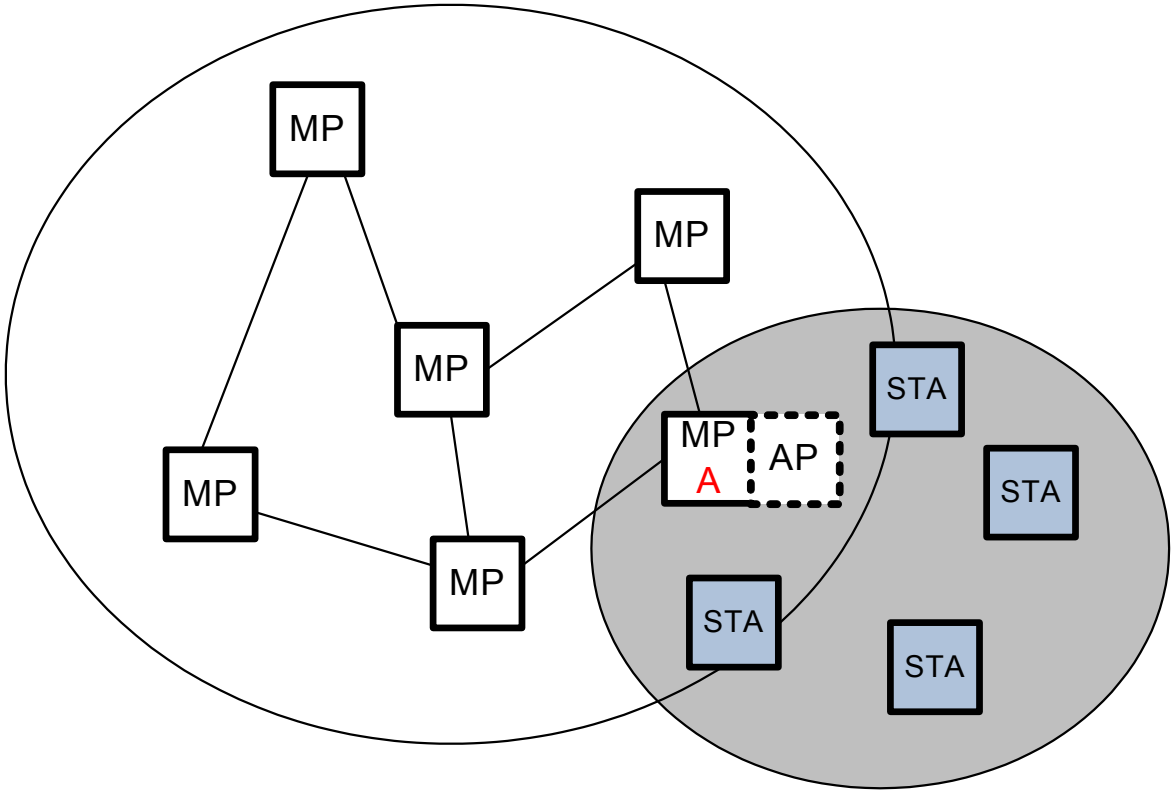
MP-only network

- **Only MPs connect with each other**
  - No need for „legacy“ beacon IEs
  - No stations in the network
    - No AP functionality provided



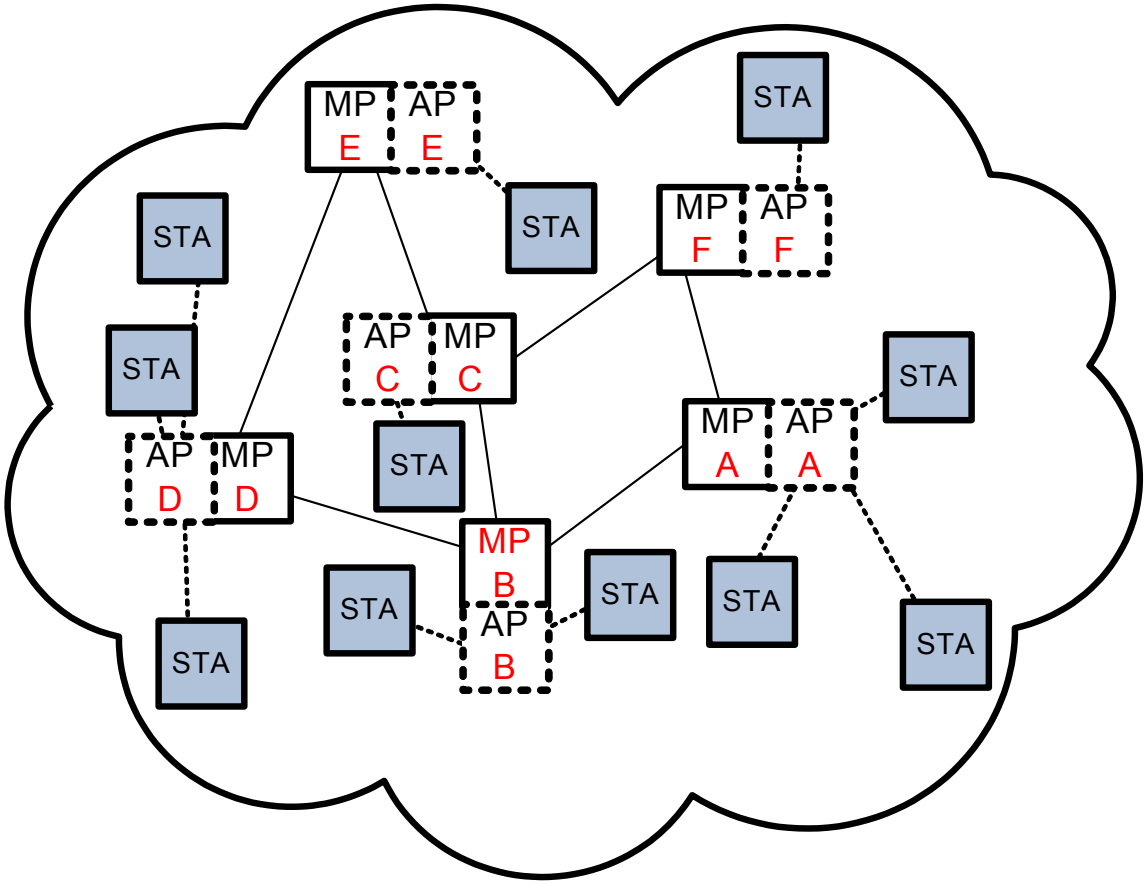
Combined Mesh and infrastructure BSS

- **MP A is collocated with an AP**
  - Only this combined device needs to send information for STAs
- **Uncombined MPs do not serve STAs**



All MPs collocated with APs

- **Shall all beacons carry the same information?**
- **Shall the Mesh provide to STAs a seamless view of the network?**
  - How to ensure?
  - Is that 802.11s business?



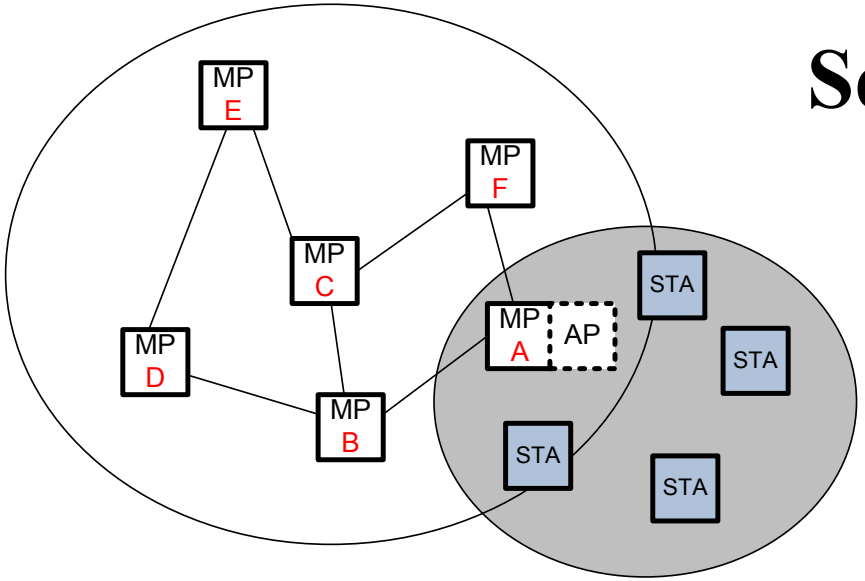
Competing IEs

- **What is the most important information in a beacon frame?**
- **If beacon frame size increases, the frame body may not provide sufficient room for all desired IEs**
  - How to decide on the IEs to include?
  - Schedule (round robin etc.) IEs for inclusion?
  - Time-critical IEs?
- **Can IEs be dropped?**
- **What does 802.11 say in the absence about expected IEs?**

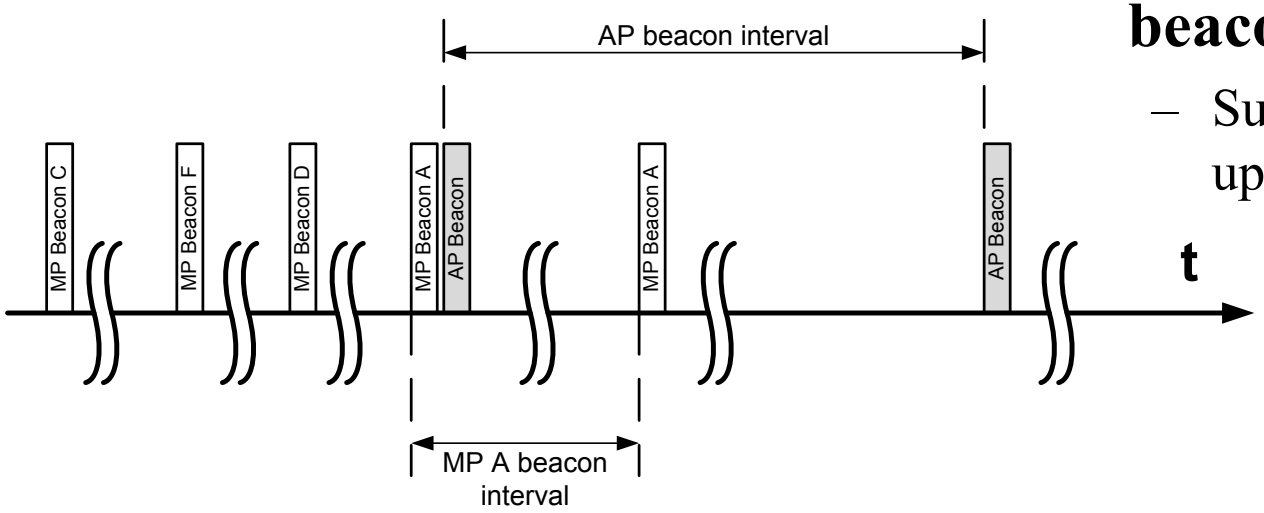
Concept: „Mesh-only“ beacon

- **Create a beacon that is designed specifically for the needs of a Wireless Mesh Network**
- **Do not integrate “legacy” elements**
  - Avoid association attempts from STAs
- **Optimize structure for Wireless Mesh Network**
  - Avoid “legacy” elements
- **No need to tweak beacon frame to avoid compatibility issues with existing 802.11 compliant devices**
- **Possibility to split information among multiple “Mesh-only” beacons**
  - Provide for possibility of beacon frame fragmentation/aggregation

Separate beacons



- **Separate logical „entities“ send separate “group messages” (beacons)**
- **Allow for different beaconing intervals**
  - Supports different update intervals



Con "Mesh-only" beacon

- **Remain single beacon frame format for all 802.11 amendments**
  - Keep Mesh and non-Mesh consistent
    - Mesh beacon has additional IEs, but no other changes
  - No introduction of a new management type frame
- **Avoid some overhead**
  - Each separate frame needs separate PHY (PLCP header, preamble etc.) & MAC (backoff)
- **Easily support the most likely use case**
  - MP collocated with an AP

Pro "Mesh-only" beacon

- **Avoid overhead of compatibility**
  - Why put the burden of beaconing on MPs?
    - STA communicates with STA
    - STA communicates with AP
    - STA **cannot** communicate with MP
  - If MP and STA/AP are disjoint entities, there is no need to share functionality/signaling overhead
- **Allow for logical separation of AP/MP functionality**
  - Orthogonal design
- **Flexible solution to adopt to the specific Mesh needs**

Conclusion

- **Separation of beaconing proposed**
  - Mesh vs. non-Mesh
  - Helps to overcome overhead
  - Allows for different beaconing intervals
  - Optimized contents
  - Increase flexibility
  - Avoid compatibility issues with existing devices
- **Orthogonal concepts should use orthogonal mechanisms**
- **Supports TGs motto ("Perfection is achieved not when there is nothing left to add but when there is nothing left to take away.")**
  - Mesh beacon keeps focused to its target objective

Straw Poll

- **Is beacon separation a concept that should go into 802.11s?**
- **Yes/No/Abstain:**

References

- P802.11-REVma-D9.0-red-line-all-pages.pdf
- Draft P802.11u_D0.03.pdf
- Draft P802.11r_D4.1.pdf
- Draft P802.11k_D7.0.pdf
- Draft_P802.11s_D1.01.pdf
- http://www.wireshark.org/