New Foundation functionality:

Distributed Time Bounded Service

provided by

DCF with priority

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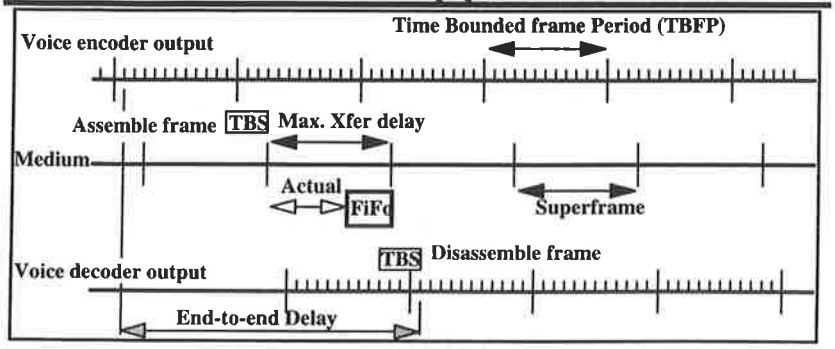
Time Bounded Alternative:

- Foundation protocol defines optional PCF to support Time Bounded.
  - Limitation due to PCF overlap problems.
  - This limits larger installations.
  - Relevant for current and future frequency bands.
    - » high speed in 1.9 GHz PCS band.
    - » high speed in potential 5.2 GHz band (HIPERLAN).
- Alternative for reservation based "Time Bounded" Service needed.
- Solution: Distributed Time Bounded Service (DTBS) using priority access mechanism.

TBS voice Application:



- Delay variance is less important.
  - Only variable transfer delay up to a given maximum is needed.
  - Timing can be restored in the receiver using a FiFo.

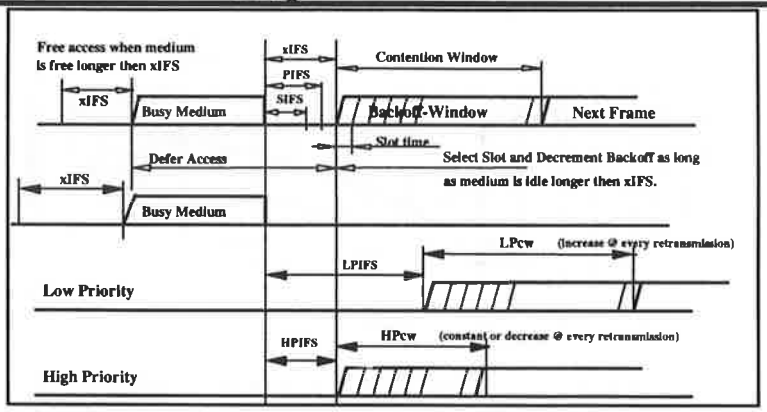
Required Characteristics:

- No overlap limitations between the *Asynchronous* and *DTBS* service.
- Low transfer delay for all priority levels to support "Bursty" traffic.
- Low transfer delay probability distribution for High Priority traffic.
- Maximum delay limit for DTBS acceptable to support Voice applications.
  - 20-30 msec frame times should be acceptable.
  - longer delays acceptable for local connections.
- Low impact on *"Low Priority only"* delay and throughput characteristics.

How to provide priority:

- **Different IFS values per priority (HPIFS<LPIFS).**
  - **Low priority traffic will defer earlier.**
  - **Low priority will decrease Back-off delay later compared to high priority traffic.**
  - **Full independence between priority levels possible but not necessary.**
- **Different Contention Window (CW) values per priority.**
  - **Average selected Back-off delay will depend on CW-ratio.**
- **Different CW increase policies per priority.**
  - **CW can be constant or even decrease for retransmissions.**
  - **Load of High Priority traffic should best be limited.**

Priority in CSMA/CA:

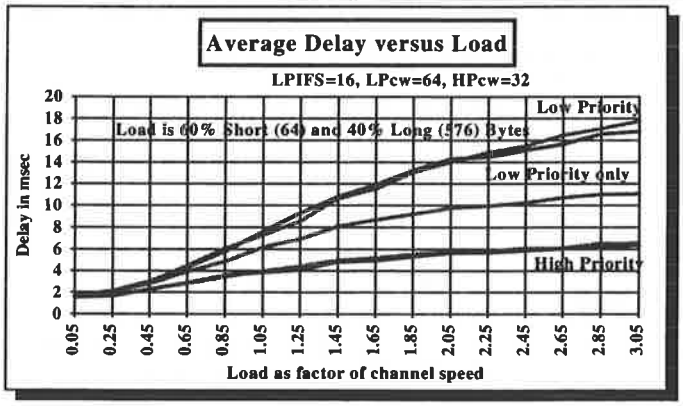


Only need differentiation in existing CSMA/CA parameters.

Simulation approach:

- Two parameter sets analyzed:
  - LPIFS=HPIFS + 16, LPcw = 64, HPcw = 32 slots.
  - LPIFS=HPIFS + 32, LPcw = 32, HPcw = 32 slots.
- Frame length distribution:
  - 60% Short (64 Bytes) and 40% Long (576 Bytes).
- 3 High and 6 Low priority stations.
- Simulations as function of Load.
- Characteristics analyzed:
  - Average delay with and without High Priority load.
  - Delay distribution per priority level.
  - Average delay impact for "Low Priority only" (compared to LPIFS=HPIFS case)

Average Delay performance:



Significant priority difference when load increases.

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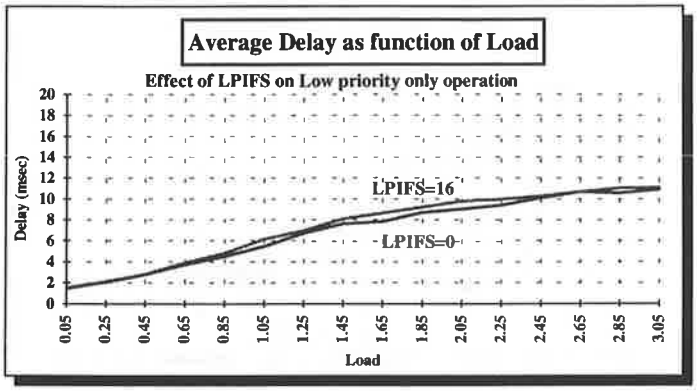
Low Priority only impact:



No difference at low Loads, minor impact during higher loads, showing lower Throughput.

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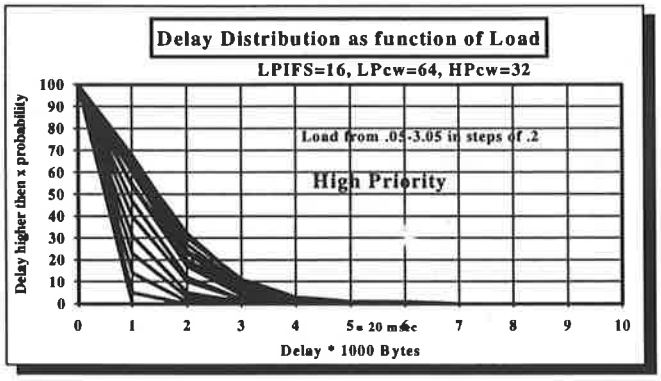
Delay Distribution:



- 20 msec max delay can be met even in high priority overload case.

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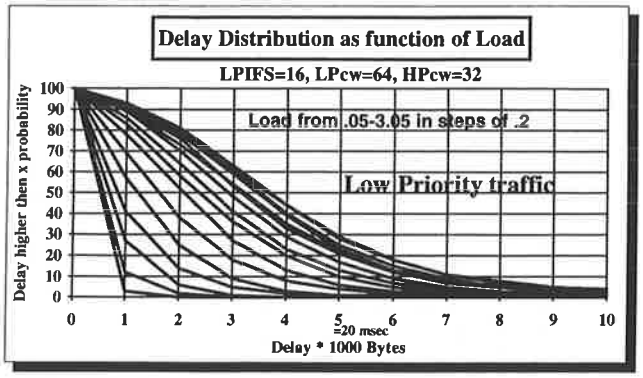
More Delay Distribution:



- **Both Low and High Priority traffic load increases in this simulation.**

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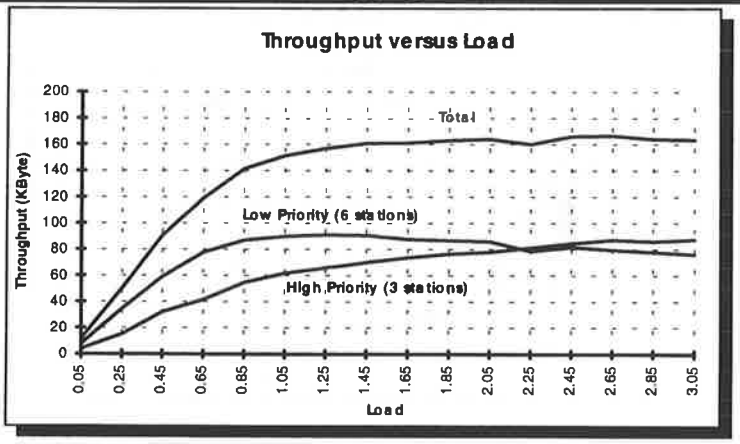
Throughput:



High priority traffic gets higher throughput.

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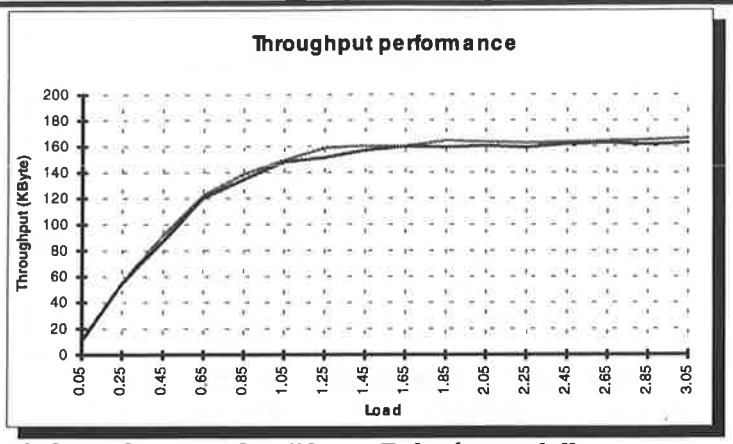
Throughput impact:



Minimal impact for "*Low Priority only*".

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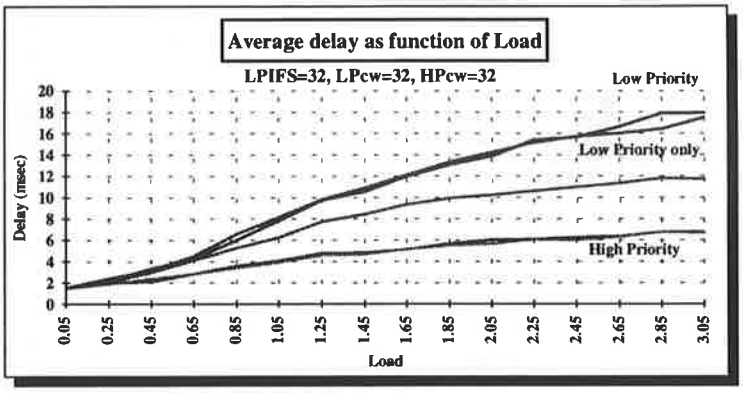
Independent priority case:



- **Very similar priority behaviour.**

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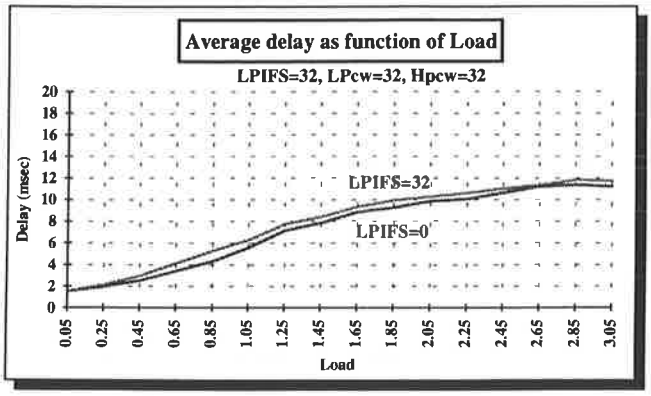
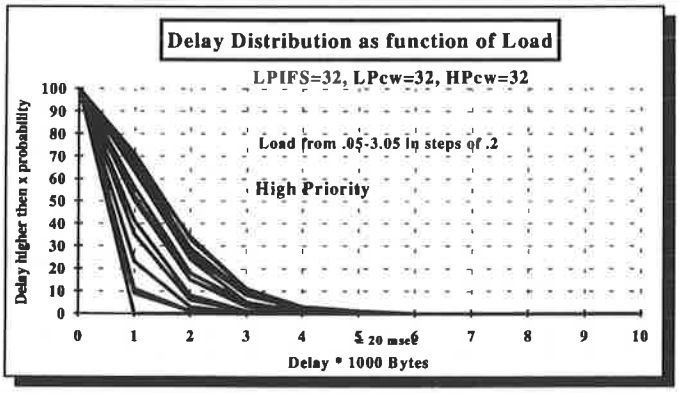
Impact on "Low Priority" only:



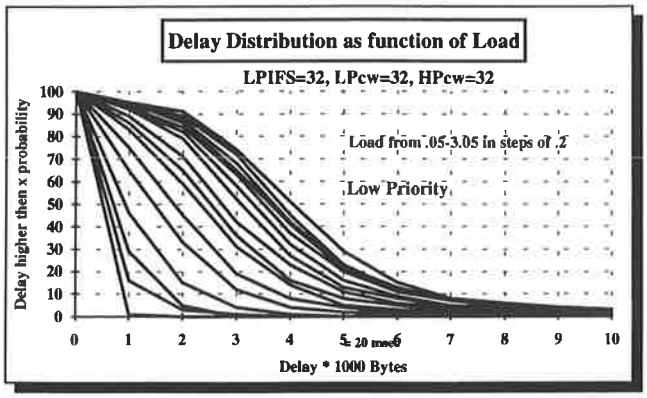
- Impact at higher loads causing somewhat lower Throughput.

HP Delay Distribution:



Very similar performance despite incomplete priority separation.

LP Delay Distribution:

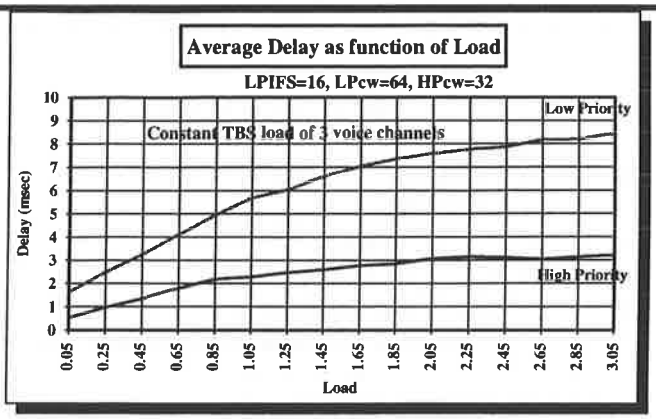


- Somewhat different profile at high loads.

Repetitive High Priority Load:

- Voice traffic is not "Bursty"
  - Repetitive Connection oriented traffic is a fixed Load.
  - Assumption is that High Priority Load is limited.
- Fixed High Priority Load Simulation:
  - Assumed 3 (simplex) Voice channels (32 Kbps ADPCM)
  - Framing period of 30 msec (120 Bytes / frame)
- Need more evaluation to determine effect as function of High Priority Load, and at different Framing periods.

Fixed load characteristics:



Fixed 120 Byte high priority frame size at 30 msec frame intervals.

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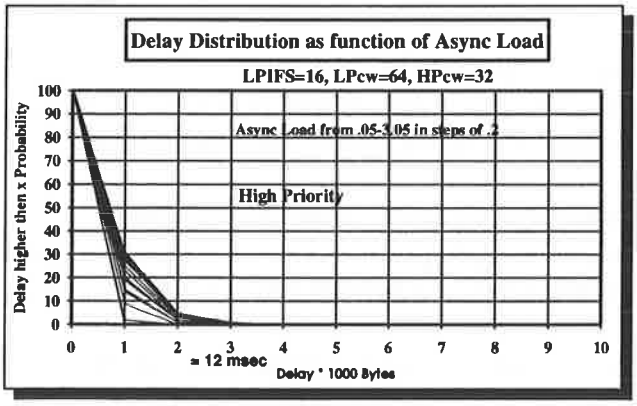
Fixed High Priority Load:



Lower maximum delay limit possible

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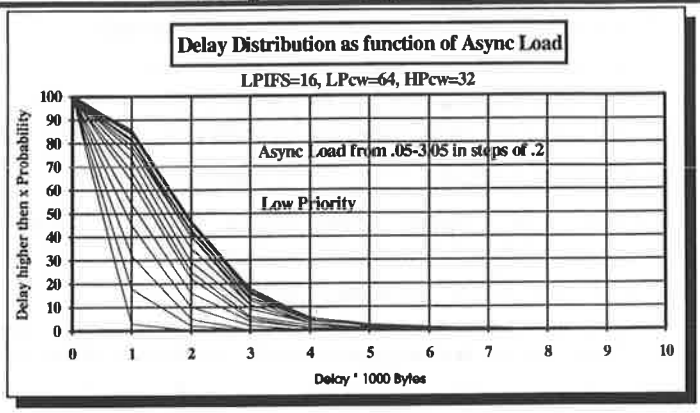
Low Priority Delay Distribution:



Low impact on Low Priority distribution:

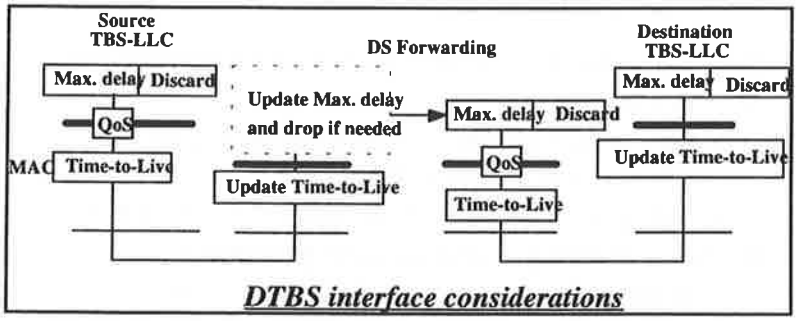
Howmany Priority levels:

- **Only two levels needed to distinct Asynchronous from DTBS traffic.**
- **It makes much sense to have different priority levels between stations and AP's.**
  - **AP will typically handle large percentage of the total traffic.**
- **Multiple priority levels can be provided.**
  - **High priority: HPIFS = 2, HPcw = 32 For DTBS.**
  - **Medium priority: MPIFS = 2÷16, MPcw = 32 For Async AP.**
  - **Low priority: LPIFS = 2÷16, LPcw=64 For Async stations.**
- **Stations can manage their Queue's such that the DTBS Queue can given higher access priority.**

How to use Priority:

- Use Quality-of-Service (QoS) parameter.
  - QoS to contain a "*Max. transfer delay*" value.
  - For Async traffic this can be set to "MAX."
  - For DTBS it can be set to the desired *Max. Transfer Delay*.
- MAC to translate QoS into Priority level.
- If QoS is anything other then "MAX.", then the MAC could put the QoS value in a "*Time_to_Live*" element code.
  - MAC could maintain this by substracting the actual transfer delay that the frame experienced in the MAC + Medium.
- DTBS to use the Asynchronous frame formats.

Possible DTBS I/F:



- A possible TBS-LLC could have Header containing:
  - Max. Delay parameter
  - Discard parameter (to allow drop of frame that experienced a too long delay, and allow recovery of timing in the receiver).

Conclusion:

- DTBS based on DCF with priority does not have an overlapping network limitation.
- In CSMA/CA priority can be controlled by 3 access protocol parameters.
- Multiple priority levels can be provided.
  - High priority: HPIFS = 2, HPcw = 32 For DTBS.
  - Medium priority: MPIFS = 2+16, MPcw = 32 For Async AP.
  - Low priority: LPIFS = 2+16, LPcw=64 For Async stations.
- A QoS based I/F can be defined.
- A "Time_to_Live" parameter could be maintained in the MAC.

Motion:

Move:

To add a "*Distributed Time Bounded*" service functionality to the Foundation MAC and to determine by the end of the May meeting whether one or both of the TBS's will remain in the standard.

Motion:

Move:

To add a "priority access mechanism" to the DCF of the 802.11 MAC.

Motion:

Move:

To use the mechanisms proposed in doc P802.11-94/58 as a basis for the "priority access mechanism" to be included in the DCF, and to further investigate its sensitivity to relevant parameters.