3rd Generation Partnership Project 2

1xEV-DV Forward Link Overview

Key Aspects of Current 1xEV-DV Forward Link Design

- Fully maintains existing cdma2000 channels and signaling structure
- Set of fixed packet sizes (384, 768, 1536, 2304, 3072, and 3840 bits)
- Variable packet durations (1.25, 2.5, 5, and 10 ms)
- Channel sensitive scheduling
- C/I feedback rate of 800 Hz
- Scheduling time granularity of 1.25 ms
- Asynchronous retransmissions
- Adaptive modulation and coding with higher-level modulation schemes (QPSK, 8-PSK, and 16QAM)
  - Modulation can be changed for retransmission (asynchronous adaptive incremental redundancy—AAIR)
- Variable duration code-division multiplexed common control channels (1.25, 2.5, and 5 ms)
- Synchronous acknowledgements
- Using existing cdma2000 turbo codes, Quasi-Complementary Turbo Code (QCTC) interleaving
- TDM/CDM capability included, exact details under study

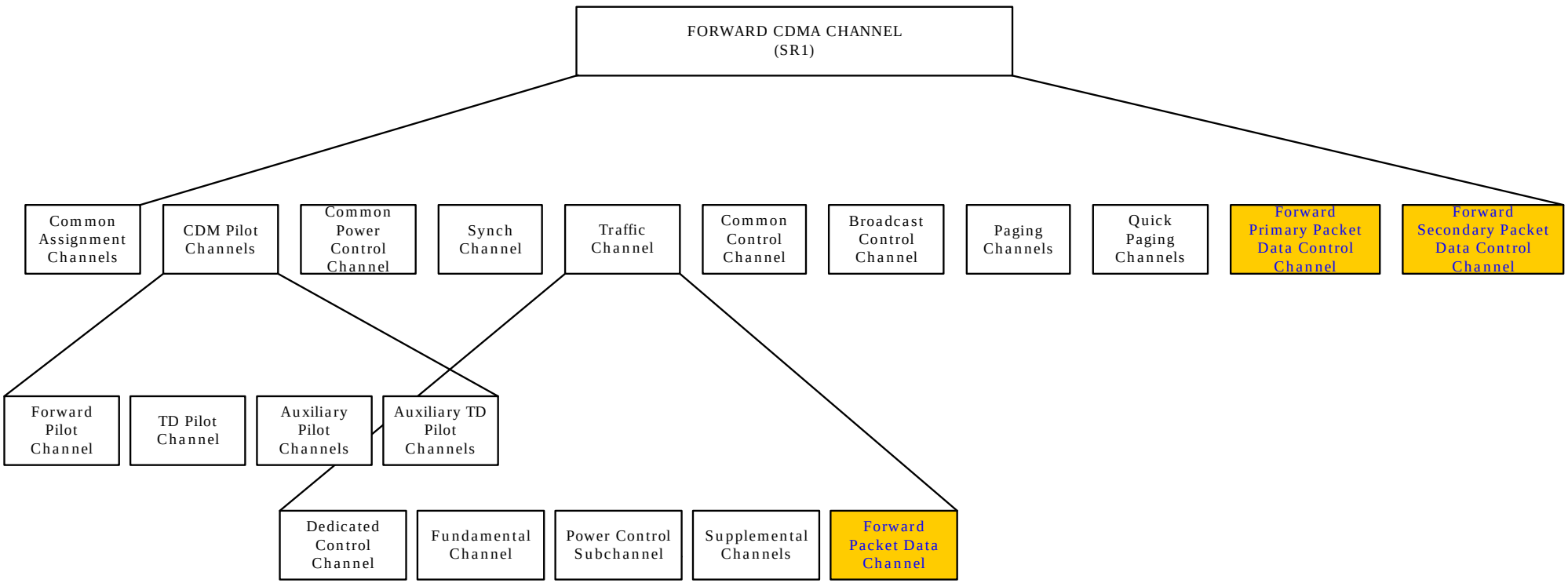
Forward Link Channel Structure

- **Current 1xEV-DV design maintains backward compatibility with previous cdma2000 and IS-95 releases, i.e. existing channels are supported in 1xEV-DV**
- **Thus, a base station supporting an 1xEV-DV forward link can also support mobile stations conforming to**
  - **TIA/EIA/IS-95-A**
  - **TIA/EIA/IS-95-B**
  - **cdma2000 Revision 0**
  - **cdma2000 Revision A**
  - **cdma2000 Revision B**

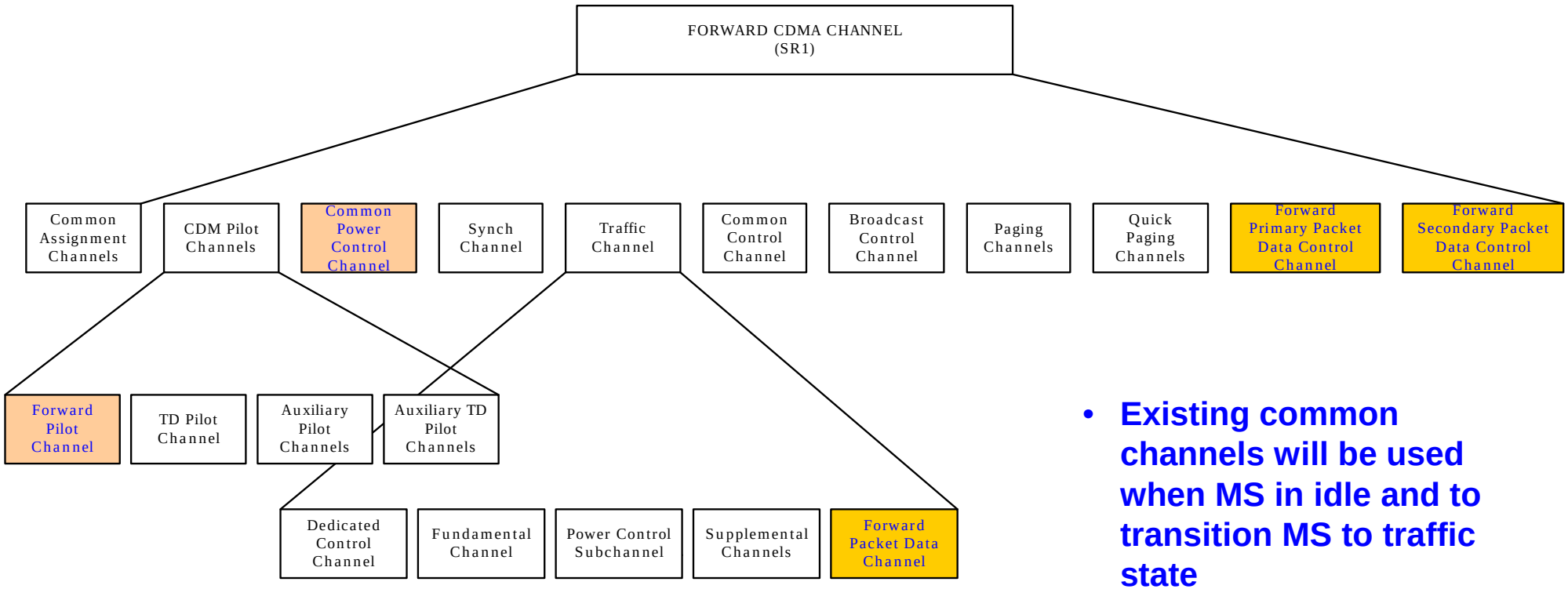
New Forward Link Channels

- **Forward Packet Data Channel (F-PDCH)**
  - **Shared by packet data users**
  - **Consist of a number of code-division-multiplexed quadrature Walsh subchannels, each spread by 32-ary Walsh function**
- **Forward Primary Packet Data Control Channel (F-PPDCCH)**
  - **Used to indicate the Sub-packet Length (duration) of F-PDCH (and of F-SPDCCH implicitly)**
  - **Optional (when blind decoding on F-SPDCCH)**
- **Forward Secondary Packet Data Control Channel (F-SPDCCH)**
  - **Used to send the scheduled user's MAC ID, ARQ Channel ID, Encoder Packet Size, and Sub-packet ID for most of the time**
  - **Used to broadcast available Walsh space information when needed**

View of cdma2000 FL Channels



FL Channels Used in DV Data-Only Mode

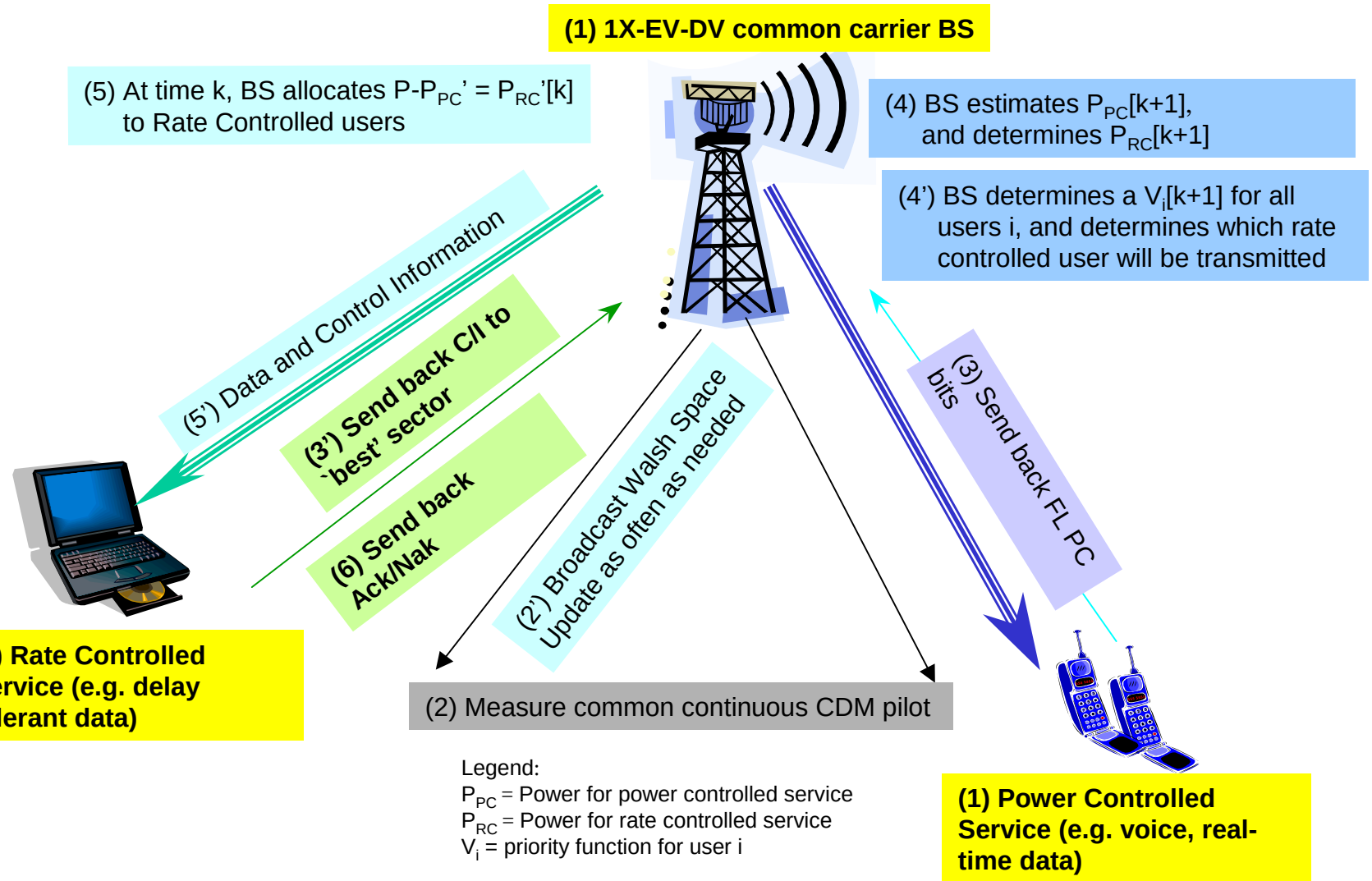


- **Existing common channels will be used when MS in idle and to transition MS to traffic state**
- **The MS can also be using other dedicated channels (e.g., F-FCH)**

Reverse Link Channels that Support Forward Link Packet Data Operation

- **Reverse ACK Channel (R-ACKCH)**
  - **ACK Channel to indicate to the base station whether a sub-packet transmitted on the F-PDCH was received successfully or not**
- **Reverse Channel Quality Indicator Channel (R-CQICH)**
  - **Used by the mobile station to indicate to the base station the channel quality measurements of the best serving sector**

Basic Operation



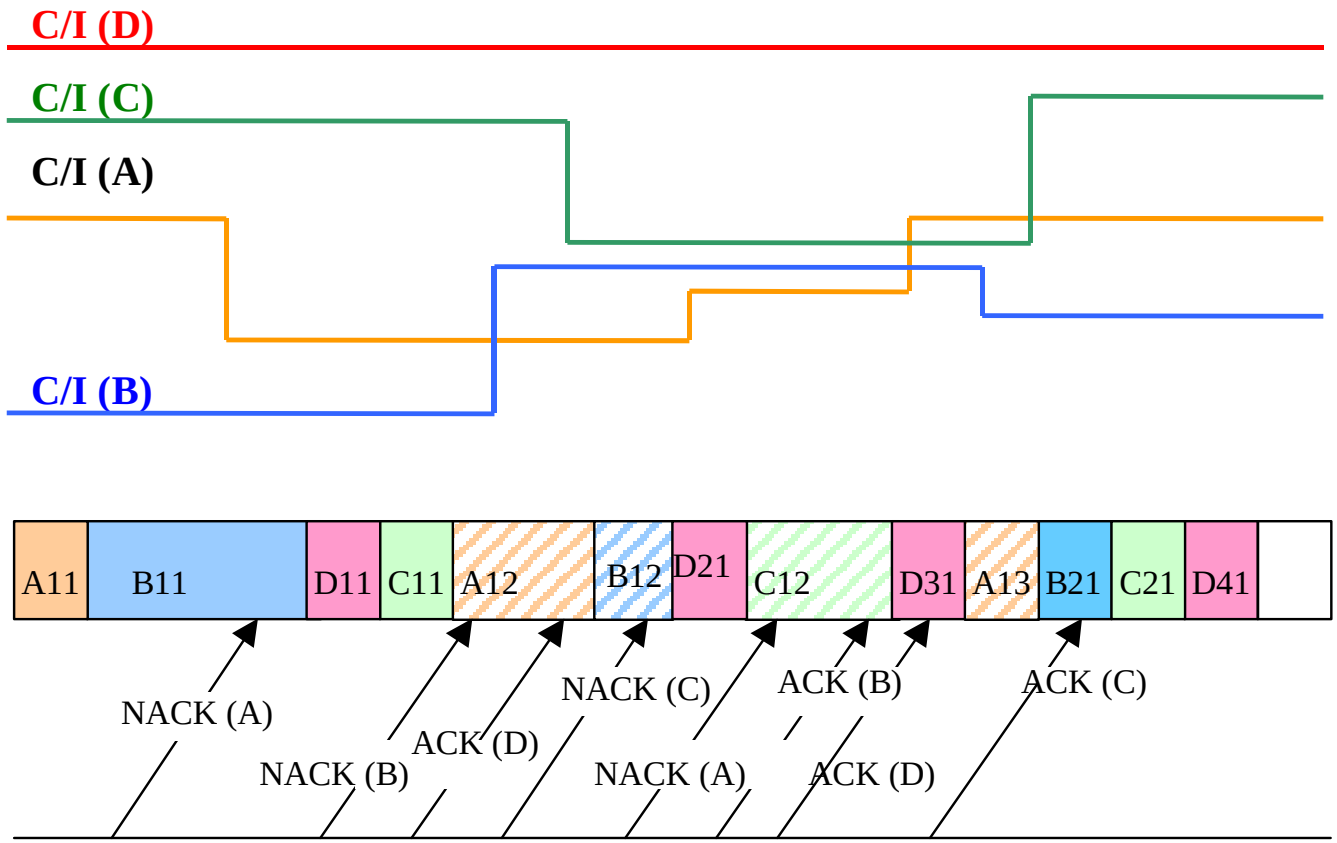
Forward Link Operation Overview (1)

- The BS transmit power and code space is dynamically shared between the rate controlled packet data users and power controlled circuit switched voice/data users
- The Forward Link for the power controlled circuit switched voice/data is identical to cdma2000 1X
- The rate controlled packet data users share a common channel with dynamically changing code space and power
- Each 1xEV-DV mobile continually measures the C/I from all active BS's using the continuous F-PICH. The mobile selects the best serving cell based on the measured C/I
- The mobile transmits the C/I based on the serving sector pilot every 1.25 ms (cdma2000 power control group) back to the base station on the R-CQICH

Forward Link Operation Overview (2)

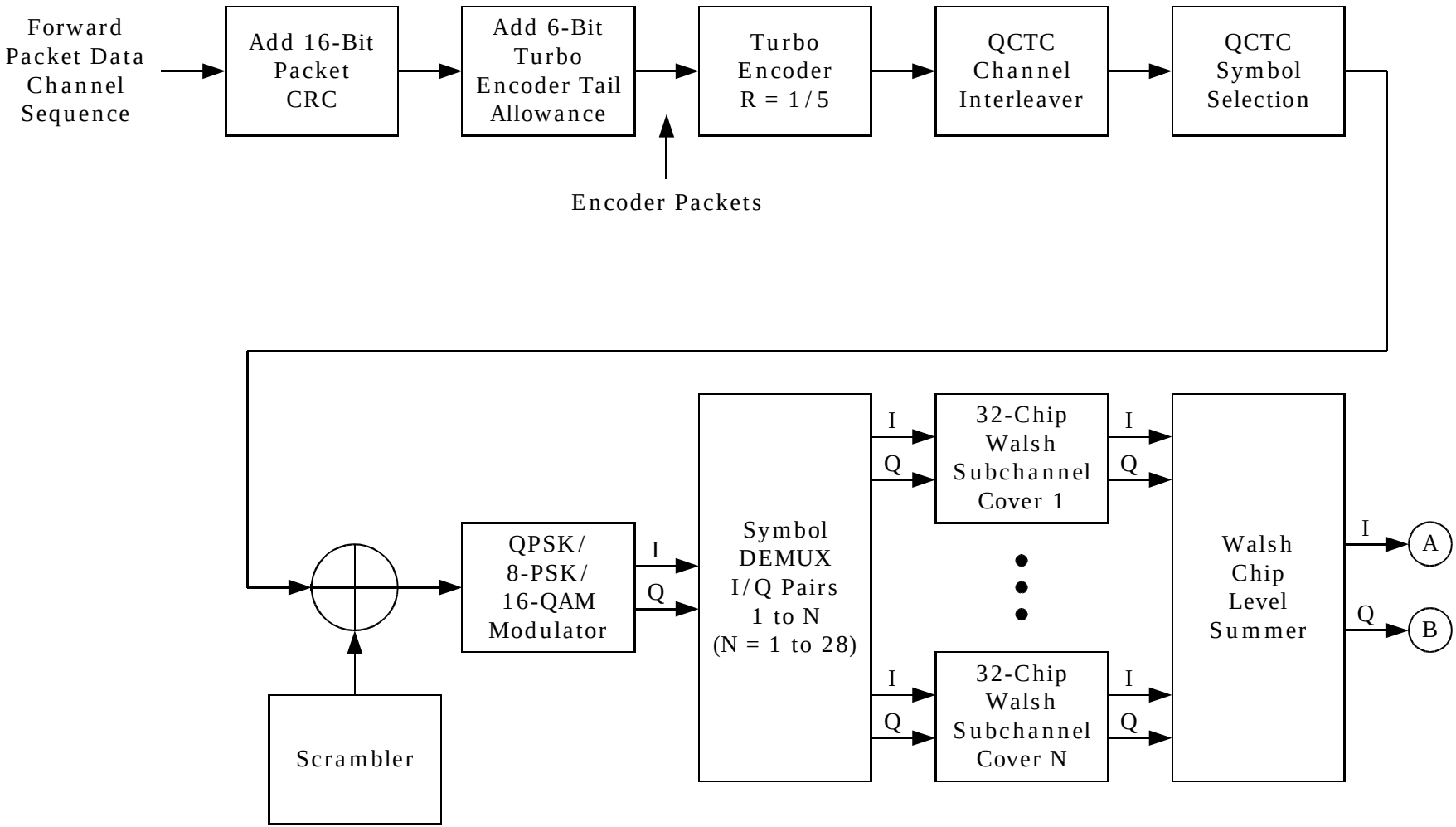
- The BS, determines the highest priority user(s)
- The BS collects the C/I feedback from all active users on the R-CQICH and schedules the transmission of the user control information and data to the users in a time-multiplexed/code multiplexed (primarily time-multiplexed) fashion
- The exact rate of the Forward Link transmission depends on the operation of the asynchronous and adaptive incremental redundancy operation
- The transmission rate is explicitly indicated to the mobile via the F-SPDCCH
- If the MS receives a transmission on the F-SPDCCH, the MS decodes the corresponding data packet on the F-PDCH
- If the mobile decodes the data packet on the F-FPDCH correctly, it sends an ACK (positive acknowledgement) to the BS. Otherwise, it sends a NACK (negative acknowledgement) to the BS
- The power control bits for the mobile's reverse link operation are signaled via the IS-2000 F-CPCCH common power control channel

Example of AAIR Operation

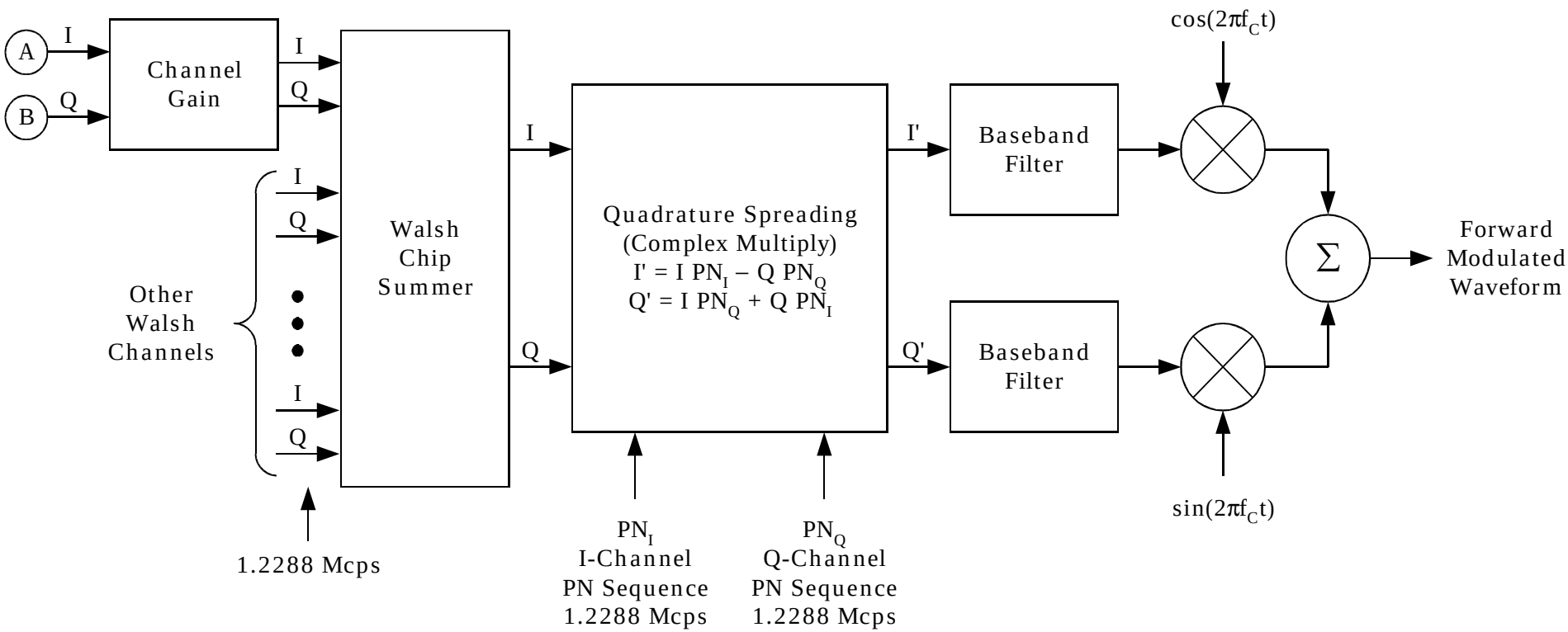


- **No synchronized timing relationship for retransmission**
- **Amount of redundancy can be varied in response to channel conditions**
- **Allows a flexible multiplexing of transmissions of different lengths**

Forward Packet Data Channel

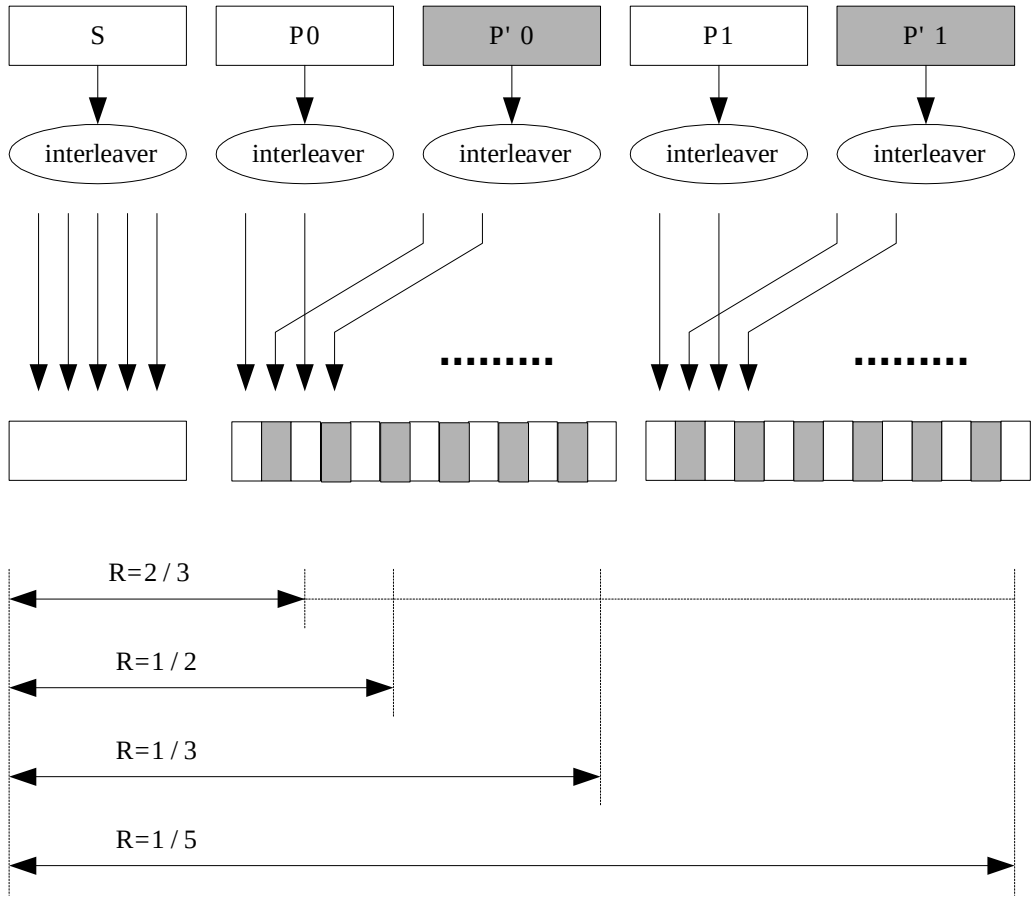


Forward Packet Data Channel (cont'd)

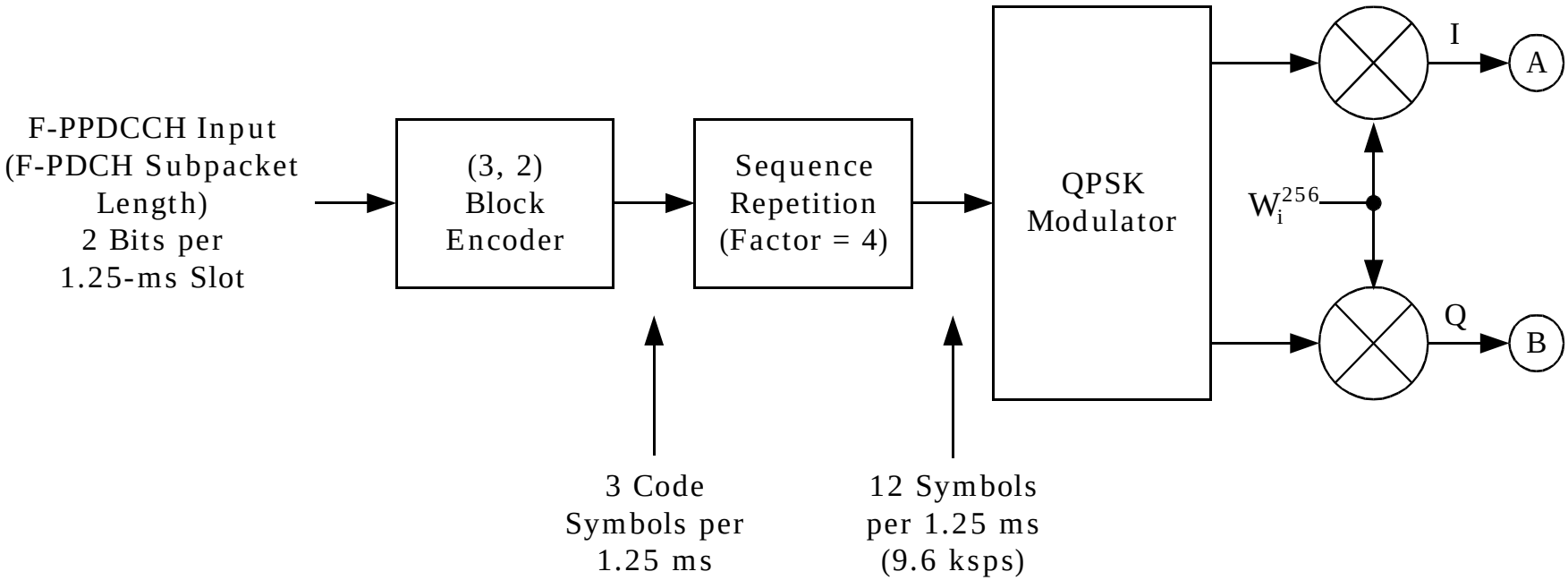


F-PDCH Channel Interleaving (QCTC)

- **Interleaves sub-blocks**
  - **Maintians systematic bits in first group**
  - **Maximum number of systematic bits are transmitted in first subpacket**

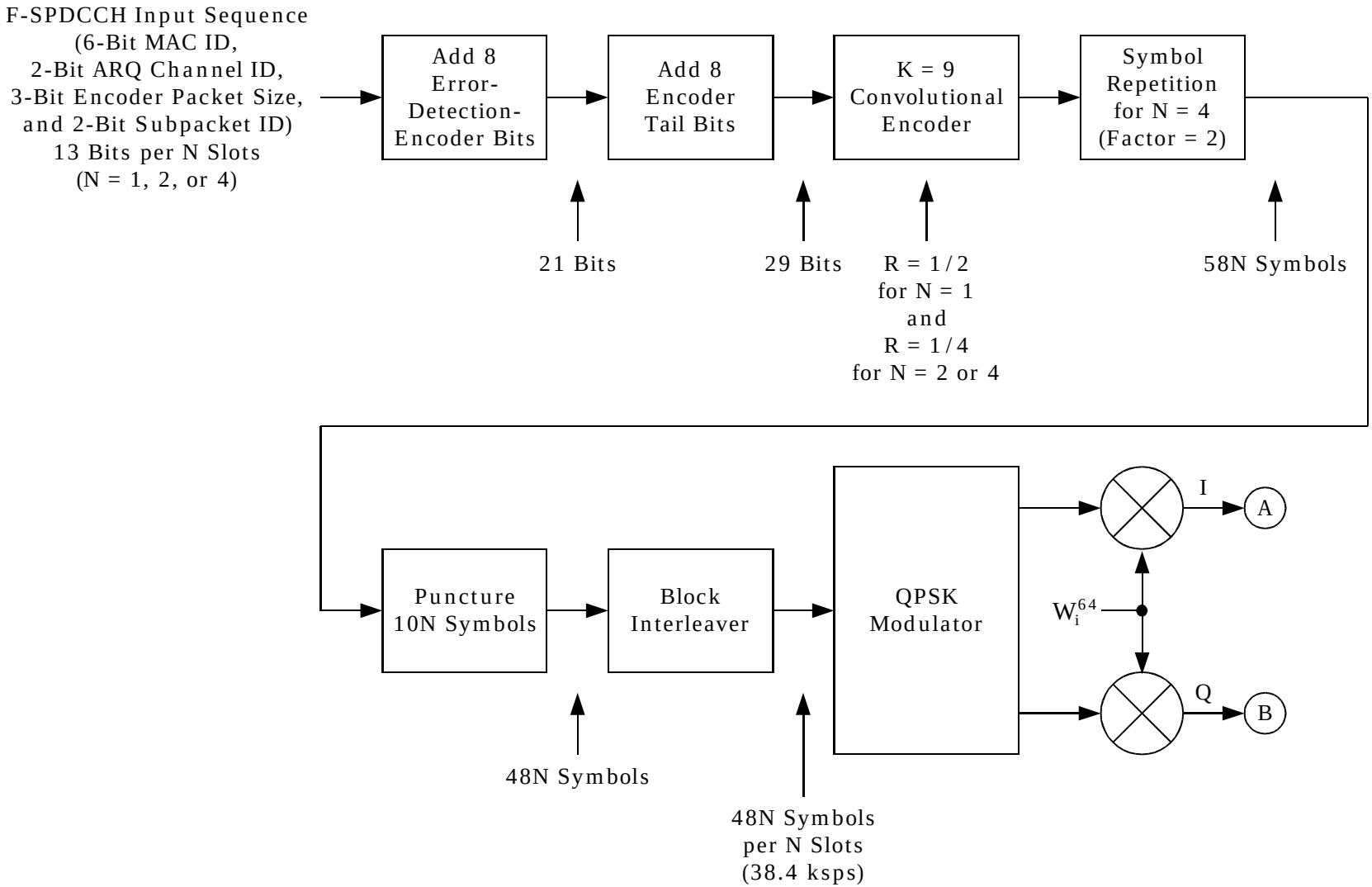


Forward Primary Packet Data Control Channel (optional)



F-PDCH Sub-packet Length (Number of 1.25-ms Slots)	Coded Symbols
1	'000'
2	'101'
4	'110'
8	'011'

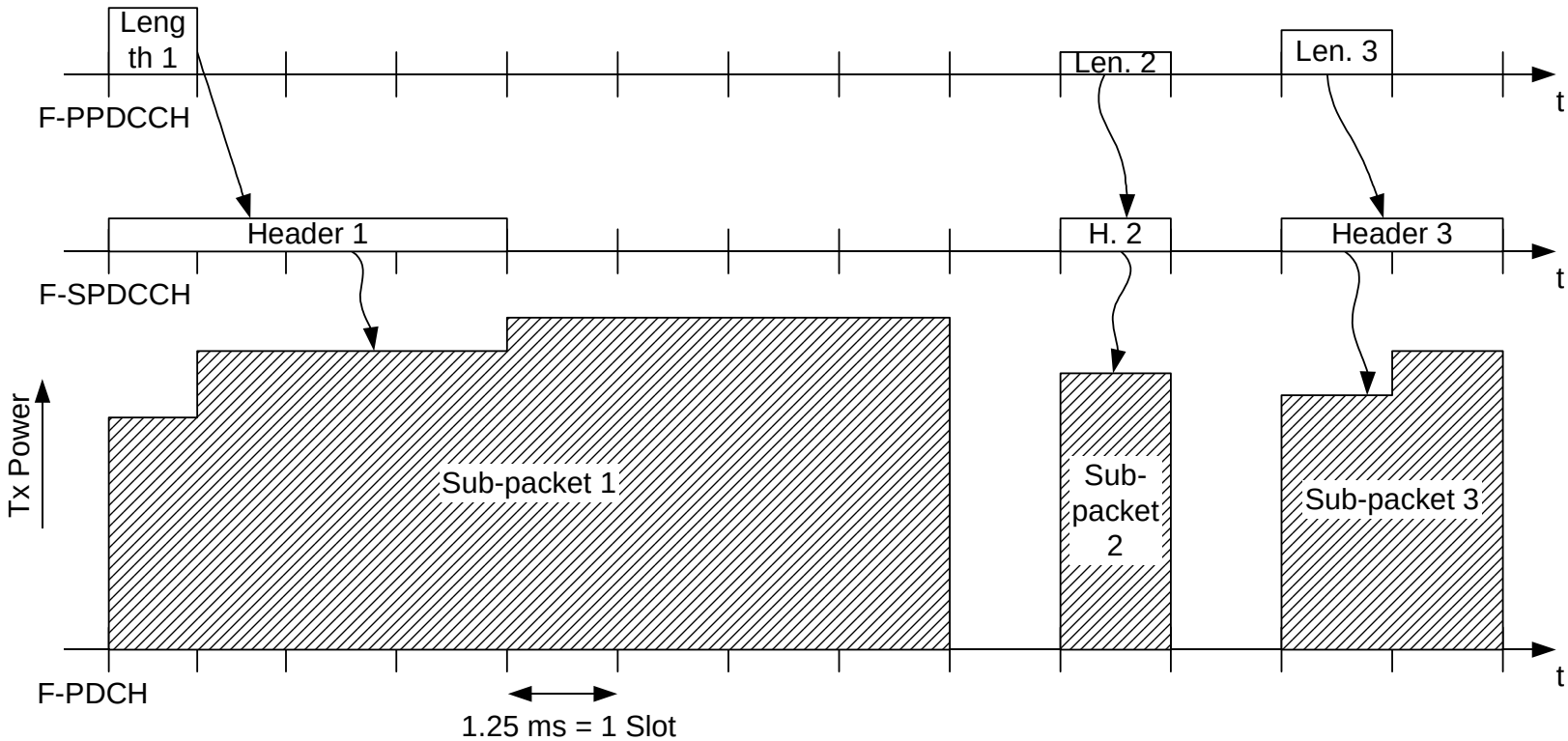
Forward Secondary Packet Data Control Channel



Operation of F-SPDCCH

- Three F-SPDCCH transmission durations (1.25, 2.5, and 5 ms)
- Indicate frame lengths of 1.25, 2.5, 5, and 10 ms
  - 5 and 10 ms frame lengths distinguished by different initializations of the CRC
- Code rates and repetition:
  - 1.25 ms: Rate ½
  - 2.5 ms: Rate ¼
  - 5 ms: Rate ¼ with repetition before interleaving
- If F-PPDCCH is not present, do blind rate determination
- Fields in message
  - 2-bit ARQ Channel identity permits 4 parallel channels per mobile station
  - 2-bit sub-packet identity permits 4 groupings of encoded symbols to be transmitted
  - 3-bit encoder packet size (384, 768, 1536, 2304, 3072, and 3840 bits)

Forward Packet Data and Control Channel Operation



Transmission of Walsh Information

- **Send on F-BCCH**
  - **Indicator to use default Walsh space, or**
  - **Actual ordering of Walsh functions to be used**
- **Use all zero MAC ID on F-SPDCCH to indicate special control information**
  - **One special control information is the WALSH_SPACE**

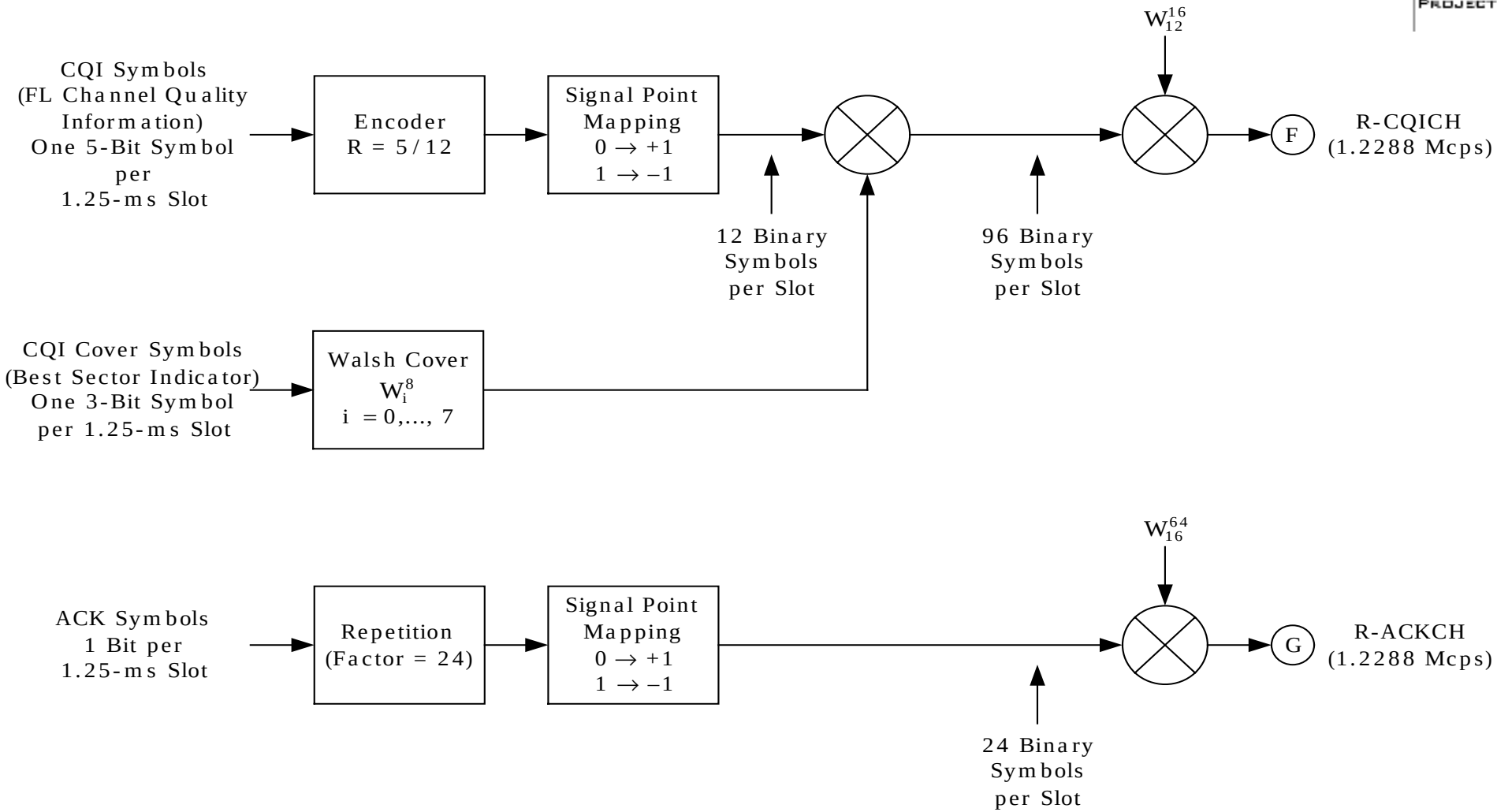
Default Walsh Space

32-ary Walsh Codes	(continued)
31	30
15	14
23	22
7	6
27	26
11	10
19	18
3	2
29	28
13	12
21	20
5	4
25	24
9	8

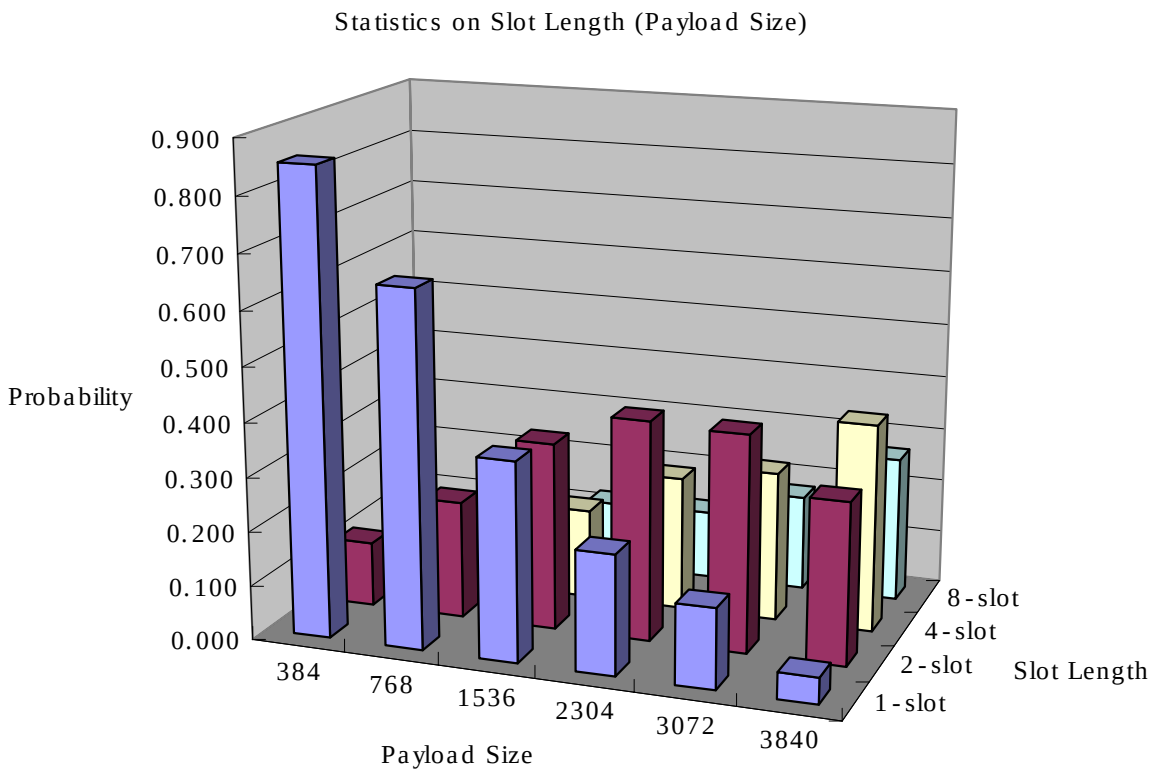
Reverse Link Channels that Support Forward Link Packet Data Operation

- Channels are code multiplexed with existing cdma2000 reverse link channels
- Reverse ACK Channel (R-ACKCH)
  - ACK/NAK Channel to indicate to the base station whether a sub-packet and F-SPDCCH was received successfully or not
  - Transmitted off unless F-SPDCCH indicates that last subpacket was directed to the mobile station
  - ACK indicates that the packet sent on the F-PDCH was correctly decoded
  - NAK indicates that the F-SPDCCH was correctly received, but that the packet sent on the F-PDCH was not correctly decoded
- Reverse Channel Quality Indicator Channel (R-CQICH)
  - Used by the mobile station to indicate to the base station the channel quality (C/I) measurements of the best serving sector
  - C/I quantized to a 5-bit value, referenced to Pilot Channel (E_{pilot}/N_t)
  - An 8-ary Walsh function (best sector indicator) corresponding to the best serving sector is used to cover the R-CQICH transmission
  - Further spread by 16-ary Walsh code

Reverse Link Channels that Support Forward Link Packet Data Operation (cont'd)

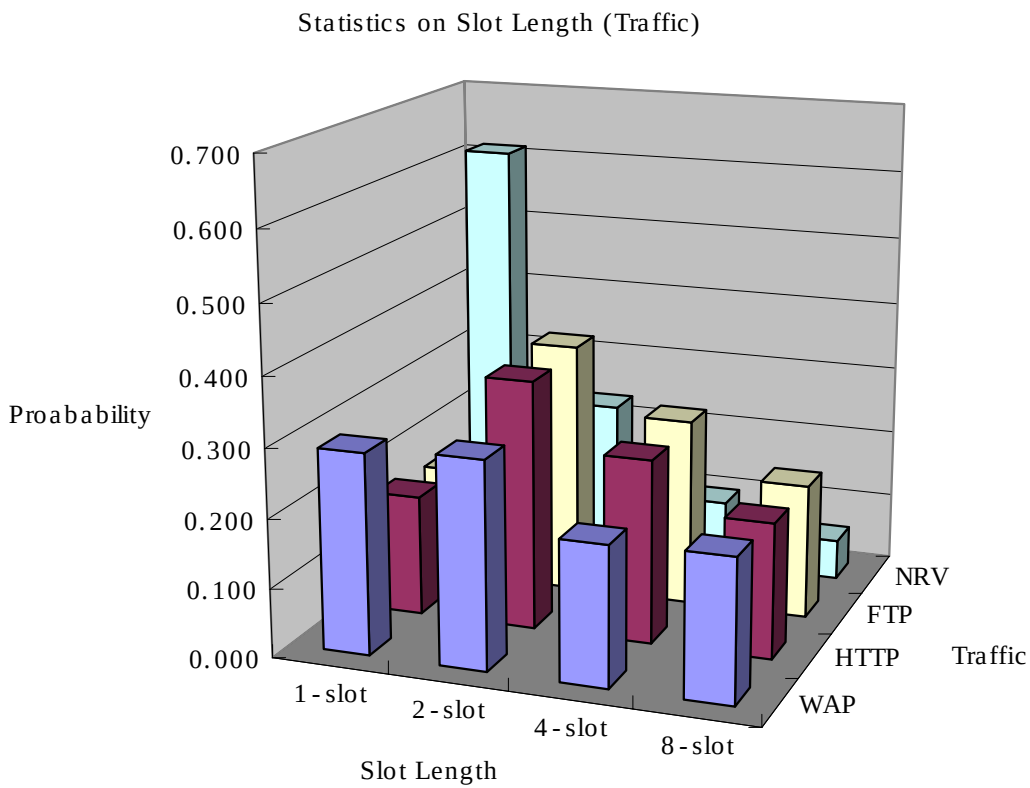


Fixed Packet Size with Variable Packet Duration – Data Only (1)



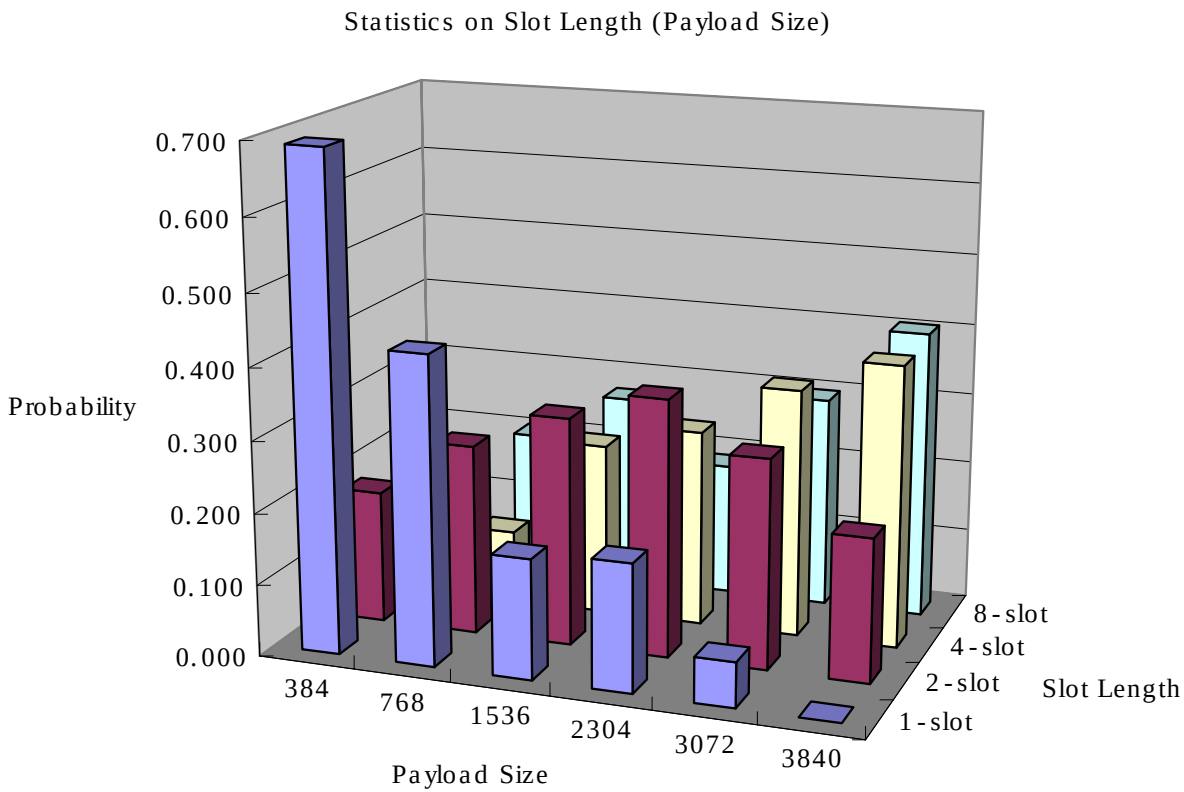
	384	768	1536	2304	3072	3840
1-slot	0.852	0.653	0.366	0.221	0.147	0.048
2-slot	0.119	0.217	0.345	0.405	0.400	0.299
4-slot	0.009	0.051	0.166	0.247	0.276	0.384
8-slot	0.020	0.079	0.123	0.127	0.177	0.269

Fixed Packet Size with Variable Packet Duration – Data Only (2)



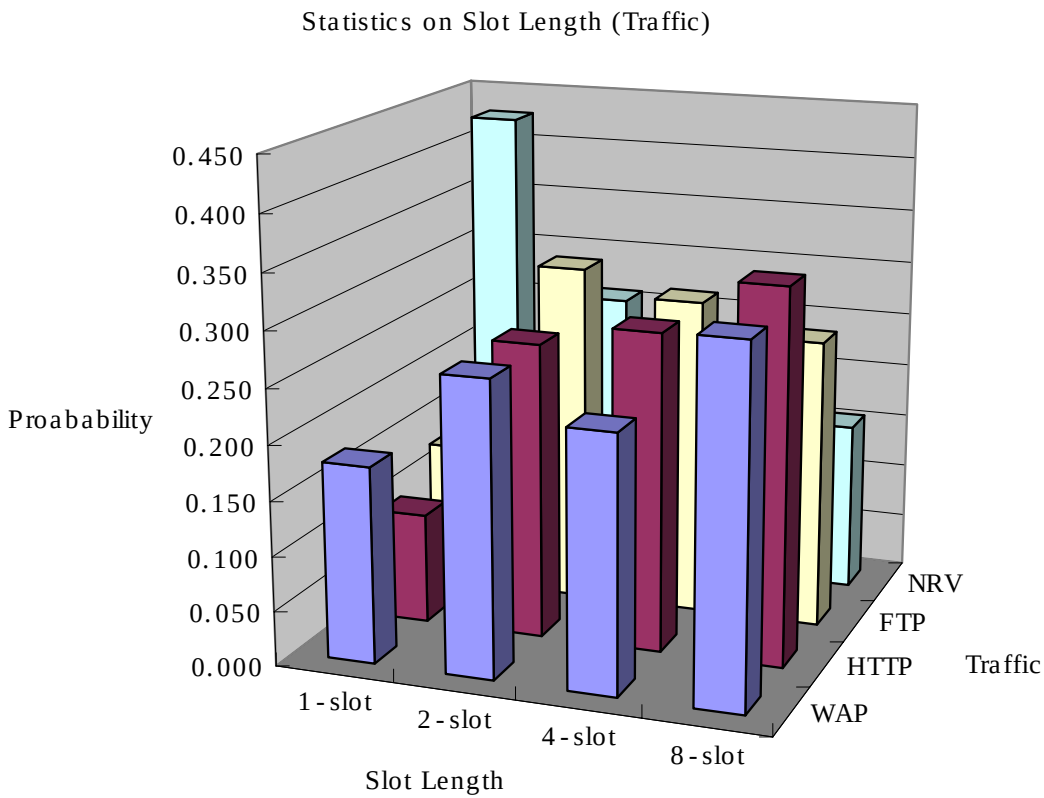
	1-slot	2-slot	4-slot	8-slot
WAP	0.291	0.300	0.202	0.207
HTTP	0.175	0.362	0.267	0.196
FTP	0.163	0.368	0.273	0.196
NRV	0.613	0.231	0.098	0.058

Fixed Packet Size with Variable Packet Duration – Data and 50% Voice (1)



	384	768	1536	2304	3072	3840
1-slot	0.691	0.429	0.168	0.178	0.063	0.000
2-slot	0.186	0.266	0.319	0.359	0.292	0.200
4-slot	0.029	0.101	0.242	0.275	0.348	0.395
8-slot	0.095	0.203	0.272	0.187	0.298	0.405

Fixed Packet Size with Variable Packet Duration – Data and 50% Voice (2)



	1-slot	2-slot	4-slot	8-slot
WAP	0.179	0.268	0.233	0.321
HTTP	0.101	0.270	0.290	0.340
FTP	0.132	0.313	0.291	0.264
NRV	0.427	0.259	0.158	0.156

Study Items/Components

- Estimation of traffic to pilot ratio for F-PDCH and rate at which F-PDCH power can be varied (closed)
- Modulation schemes for retransmission
- Enhancements to IR
- Number of MAC ID
- Efficient C/I feedback (differential feedback)
- 64QAM
- Performance enhancements for small packets
- Fast Cell Selection
- 1.25 ms slot size
- Number of ARQ channels and possible relaxing of timing requirements
- Generating CRC with MAC ID

Component Proposals

- Antenna concepts
  - Adaptive antennas
  - 4-way transmit diversity
  - Selection Transmit Diversity (STD)
  - Multiple Input Multiple Output (MIMO)
  - Differential Measurement Metric (DMM)
- Cell Selection Soft Handoff
- LA and LS spreading codes
- Maintenance Channel
- Multiple Quality Control (MQC)