

Controller Network Data Extracting Protocol – Design and Implementation

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Prerequisites and Motivation

- Vendor specific standards are expensive and difficult to interoperate.
- Automation standards have limitations in distance, number of devices or speed.
- TCP/IP is almost ubiquitous nowadays.
- Ethernet is fast-speed and fairly.

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Background

Protocol Design

- The service to be provided by the protocol
- The assumptions about the environment in which the protocol is executed
- The vocabulary of messages used to implement the protocol
- The encoding (format) of each message in the vocabulary
- The procedure rules guarding the consistency of message exchanges

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Controller Network Data Extracting Protocol

- Works over UDP
- Request/Response based

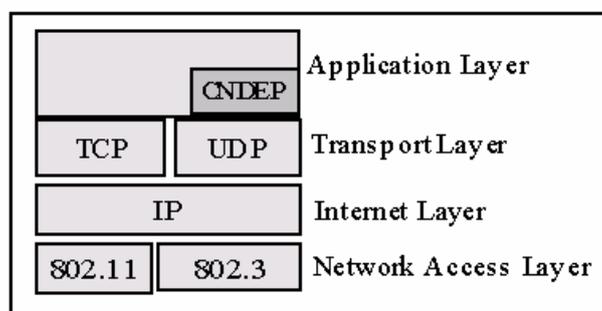


Figure 1: The place of CNDEP in TCP/IP stack.

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Controller Network Data Extracting Protocol

- Data flow between nodes

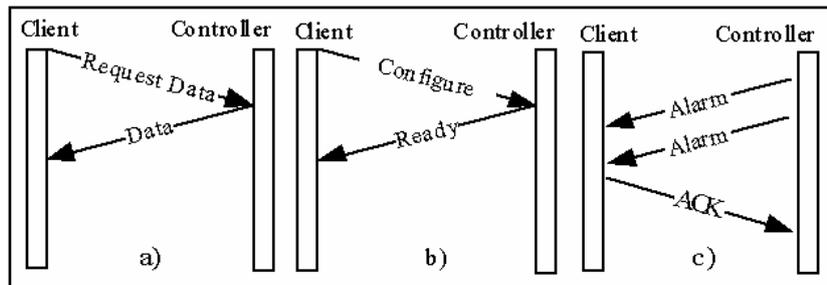


Figure 2: Protocol interactions.

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Controller Network Data Extracting Protocol

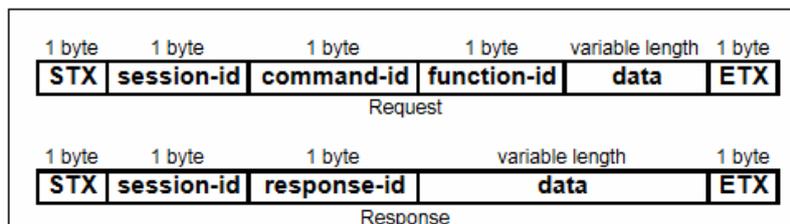
Protocol Vocabulary:

$$V_{REQUEST} = \{TEST, GET, SET\} \quad (1)$$

$$V_{RESPONSE} = \{OK, ERROR, DATA\} \quad (2)$$

$$V_{PROTOCOL} = (V_{REQUEST} \times V_{RESPONSE}) / (TEST, DATA) \quad (GET, OK) \quad (SET, DATA) \quad (3)$$

Message Format:



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Message Format (continued):

```

Message ::= { <Request> | <Response> };
Request ::= STX <Session_ID> <Command_ID> [ <Function_ID> ] [ <Data> ] ETX;
Response ::= STX <Session_ID> <Response_ID> [ <Context-Type> ] [ <Data> ] ETX;
    
```

Figure 4: BNF description of CNDEP messages.

Session_ID ::= Byte, representing the session (for retransmission).
Command_ID ::= Byte, representing the command to controller.
Function_ID ::= Byte, showing subcommand (if any).
Response_ID ::= Byte, representing the response type.
Context-Type ::= MIME Types – describes the type of the data field.
Data ::= Variable Length String.

Controller Network Data Extracting Protocol

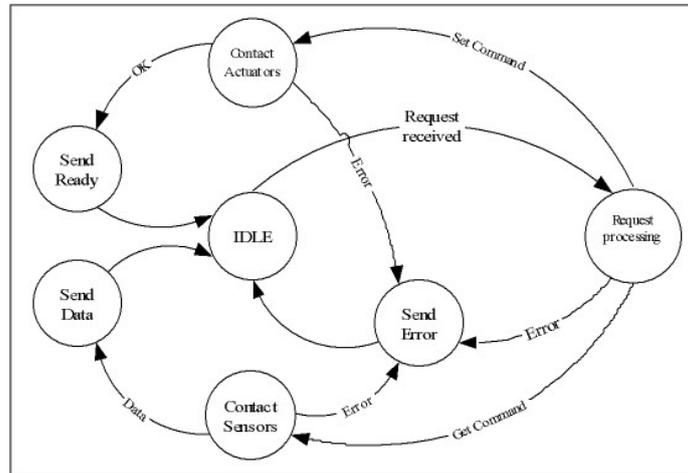
Protocol Commands:

Table 1: Some CNDEP commands

Byte value	GET				SET			
	0	1	2	122	129	253	254	255
Command name	Test (OK)	Temperature	Humidity	User Data	User Data	Temperature Options	Humidity Options	Test (Error)

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Server Application:



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Client Application:

1. Send Request;
2. If (OK or DATA not received for TIME_OUT ms)
REPEAT - -;
- Else goto 12;
3. If (REPEAT <= 0)
goto 11;
4. Generate random number T in [MIN_DELAY .. MAX_DELAY];
5. Wait T milliseconds;
6. Send Request;
7. If (OK or DATA not received for TIME_OUT ms)
REPEAT - -;
- Else goto 12;
8. If REPEAT <= 0 goto 11;
9. T=T*2;
- If (T > UPPER_DELAY)
T = UPPER_DELAY;
10. goto 5;
11. Error – Destination unreachable in REPEAT retries;
12. Done.

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Experimental analysis

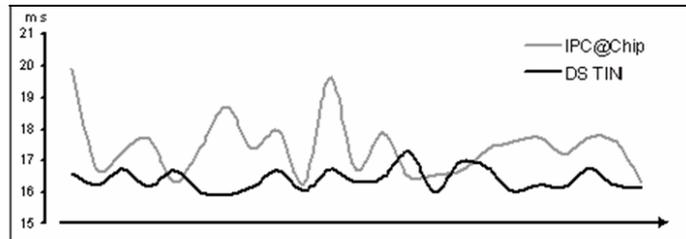


Figure 7: Request/Response times of TEST command for two different embedded systems.

Table 2: CNDEP Request/Response times

command controller	TEST			GET			SET		
	min	max	avg \pm σ	min	max	avg \pm σ	min	max	avg \pm σ
IPC@Chip	16.31	19.89	17.43 \pm 0.20	334.76	338.25	336.38 \pm 0.22	41.69	43.77	42.68 \pm 0.13
DS TIN	15.91	17.27	16.4 \pm 0.08	518.73	524.16	520.77 \pm 0.31	55.76	59.31	57.04 \pm 0.26

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Your Questions?



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