Modification on DFS and DCF procedure adapting to FCC rules in TVWS Part 2: Hidden Node

Date: 2010-03-xx

Authors:

Name	Company	Address	Phone	email
Chin Sean Sum	NICT	3-4 Hikarino-oka, Yokosuka, Japan	+81-46-847-5092	sum@nict.go.jp
Zhou Lan	NICT	3-4 Hikarino-oka, Yokosuka, Japan		lan@nict.go.jp
Junyi Wang	NICT	3-4 Hikarino-oka, Yokosuka, Japan		junyi.wang@nict.go.jp
M. Azizur Rahman	NICT	3-4 Hikarino-oka, Yokosuka, Japan		aziz@nict.go.jp
Chunyi Song	NICT	3-4 Hikarino-oka, Yokosuka, Japan		songe@nict.go.jp
Tuncer Baykas	NICT	3-4 Hikarino-oka, Yokosuka, Japan		tbaykas@nict.go.jp
Gabriel Villardi	NICT	3-4 Hikarino-oka, Yokosuka, Japan		gpvillardi@nict.go.jp
Yohannes Alemseged	NICT	3-4 Hikarino-oka, Yokosuka, Japan		yohannes@nict.go.jp
Chang Woo Pyo	NICT	3-4 Hikarino-oka, Yokosuka, Japan		cwpyo@nict.go.jp
Ha Nguyen Tran	NICT	3-4 Hikarino-oka, Yokosuka, Japan		haguen@nict.go.jp
Chen Sun	NICT	3-4 Hikarino-oka, Yokosuka, Japan		sun@nict.go.jp
Stanislav Filin	NICT	3-4 Hikarino-oka, Yokosuka, Japan		sfilin@nict.go.jp
Hiroshi Harada	NICT	3-4 Hikarino-oka, Yokosuka, Japan		harada@nict.go.jp

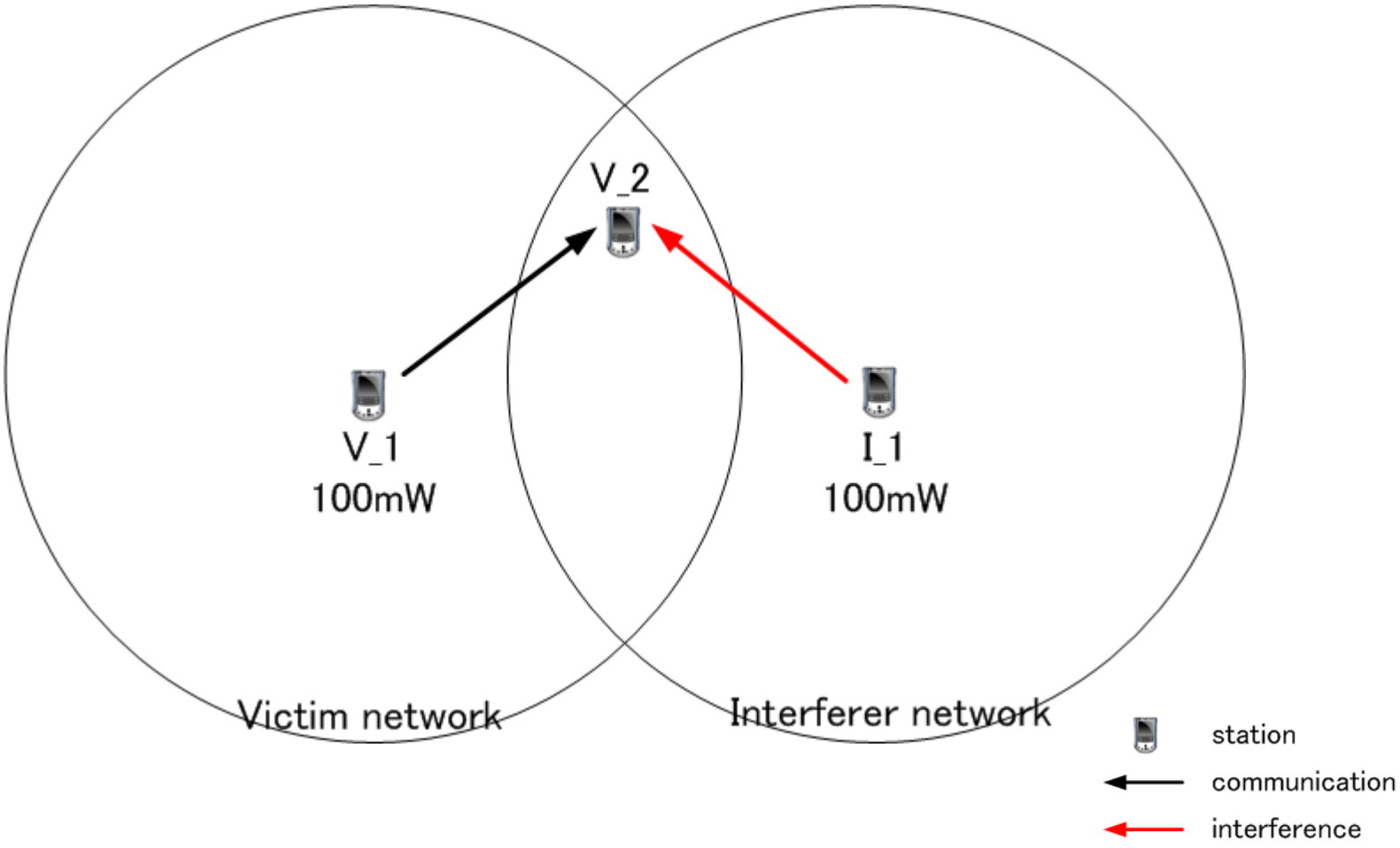
Executive Summary

- **This document describes the ‘mutation’ of the hidden node problem due to different allowable transmission power levels in the IEEE 802.11af**
- **This document proposes a solution for the ‘mutated hidden node’ problem**
- **This proposed solution requires**
  - very simple addition to existing operational procedures
  - minor changes to the existing standard
- **Summary on the required changes to legacy 802.11**
  - Minor changes to the RTS frame
  - Minor changes to the RTS-CTS operational procedure

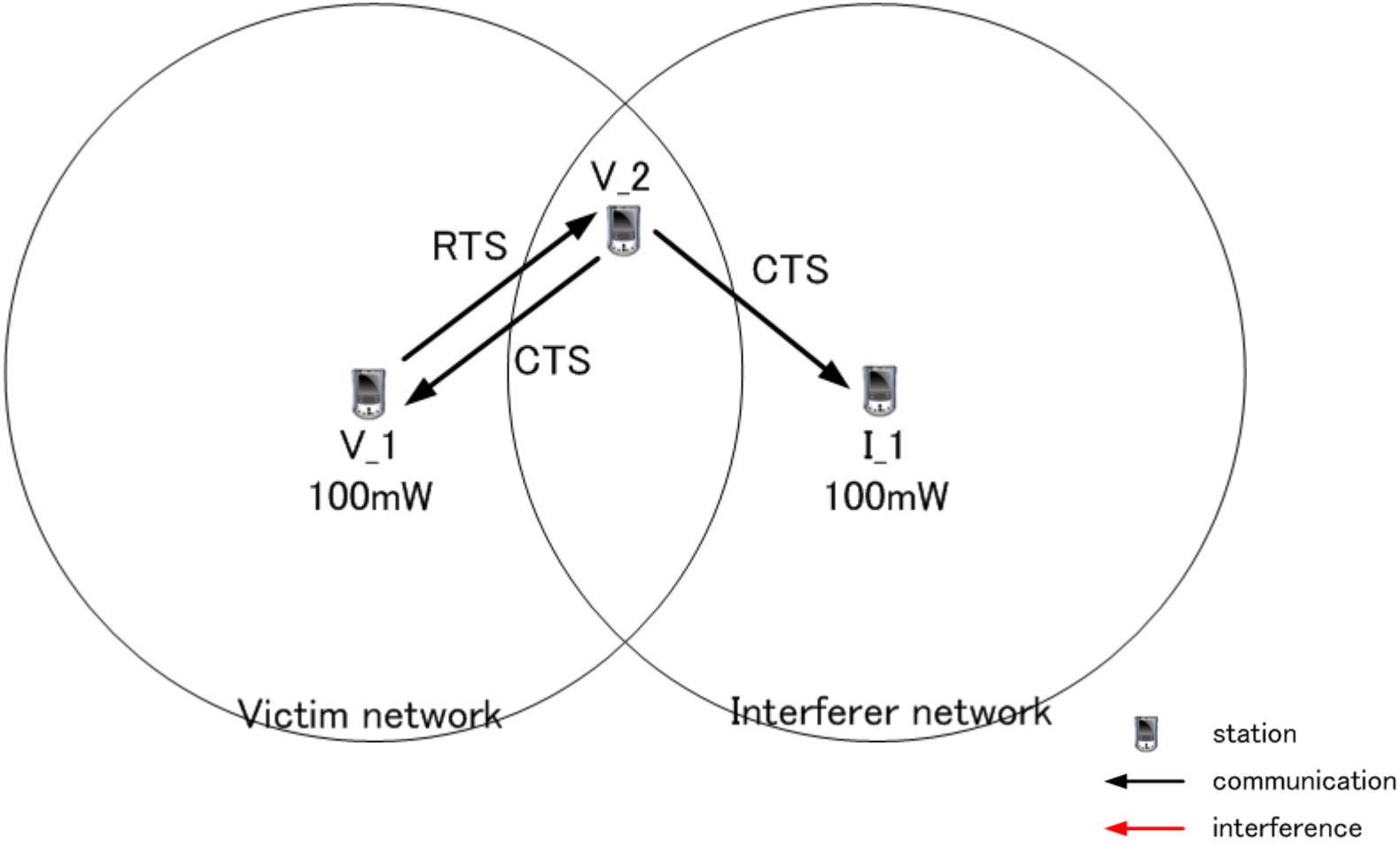
Presentation Outline

- Classical Hidden Node Problem and Solution
- Mutated Hidden Node Problem
- Proposed Mutated Hidden Node Solution
- Required Changes to Legacy 802.11

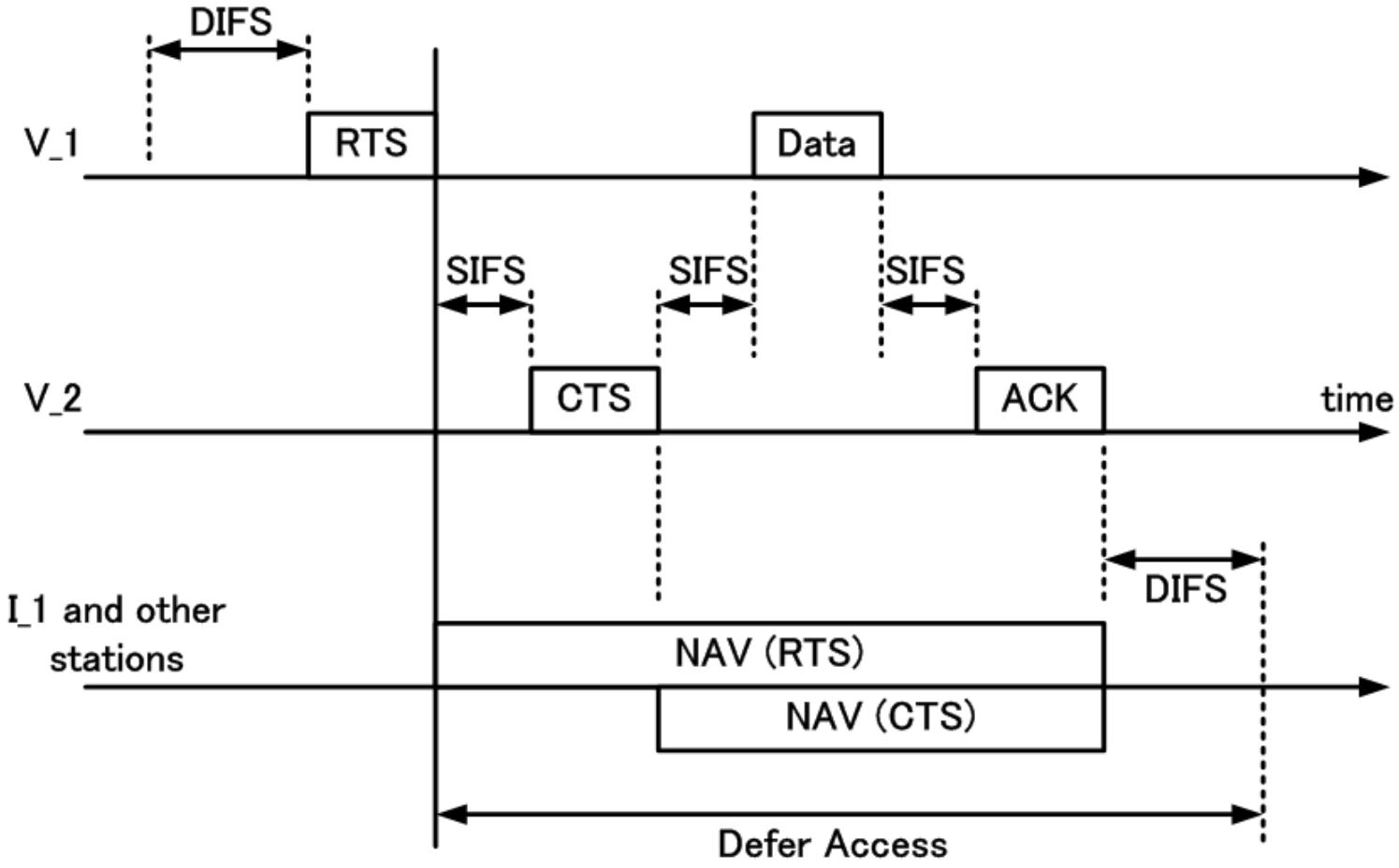
Classical Hidden Node Problem ~Scenario~



Classical Hidden Node Solution ~RTS-CTS Overview~



Classical Hidden Node Solution ~RTS-CTS Timing~

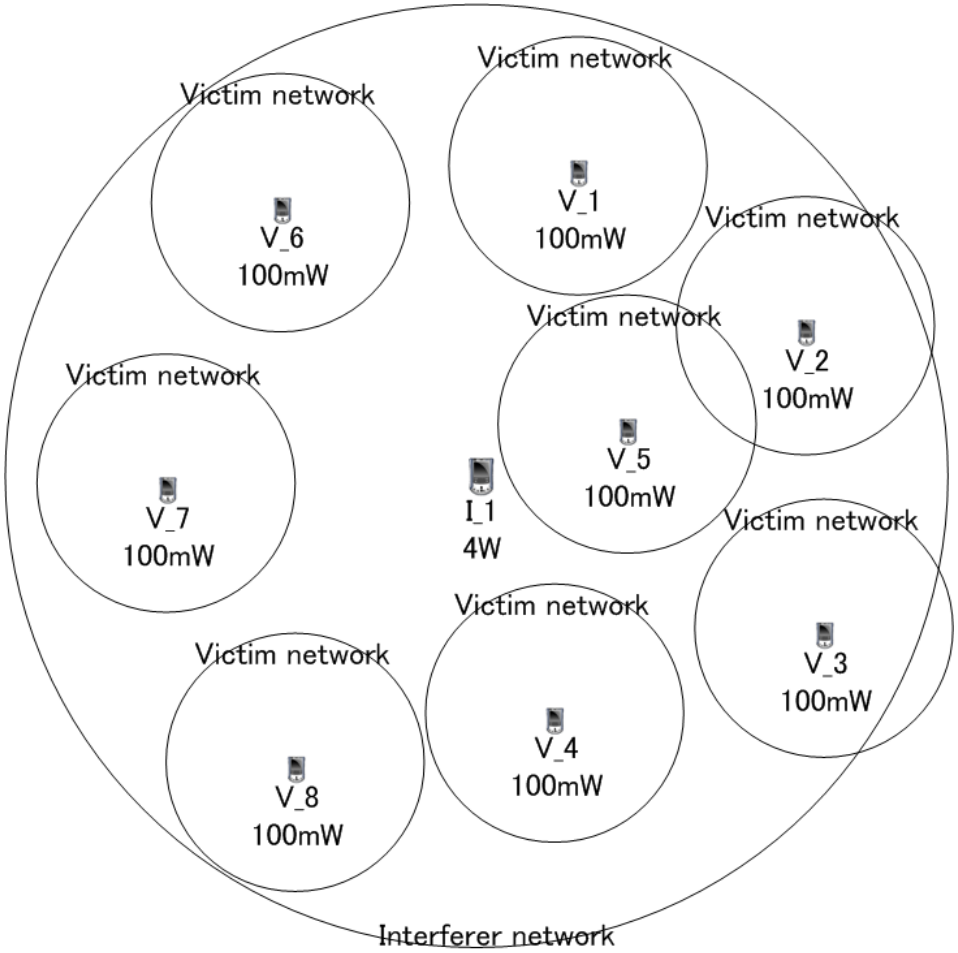


Mutated Hidden Node Problem ~The Origin~

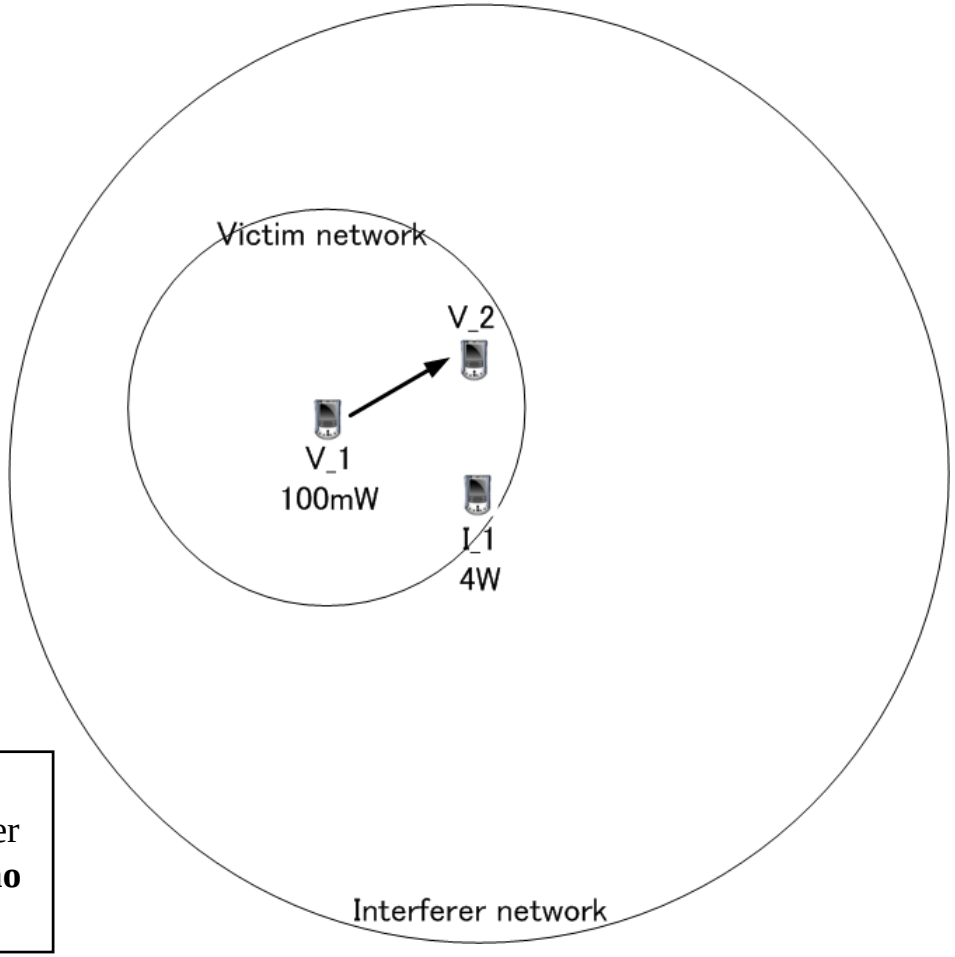
- Classical hidden node problem involved only one transmission power level and thus one operating range
- The FCC regulation for TGaf specifies multiple transmission power level: 4W, 100mW and 50mW
- As a result, the hidden node may become ‘more hidden’, hence the name ‘mutated’
- In this document, the scenarios of the mutated hidden node and the corresponding proposed solution are presented

Mutated Hidden Node Problem ~Just How Serious is the Problem~

- **Very**

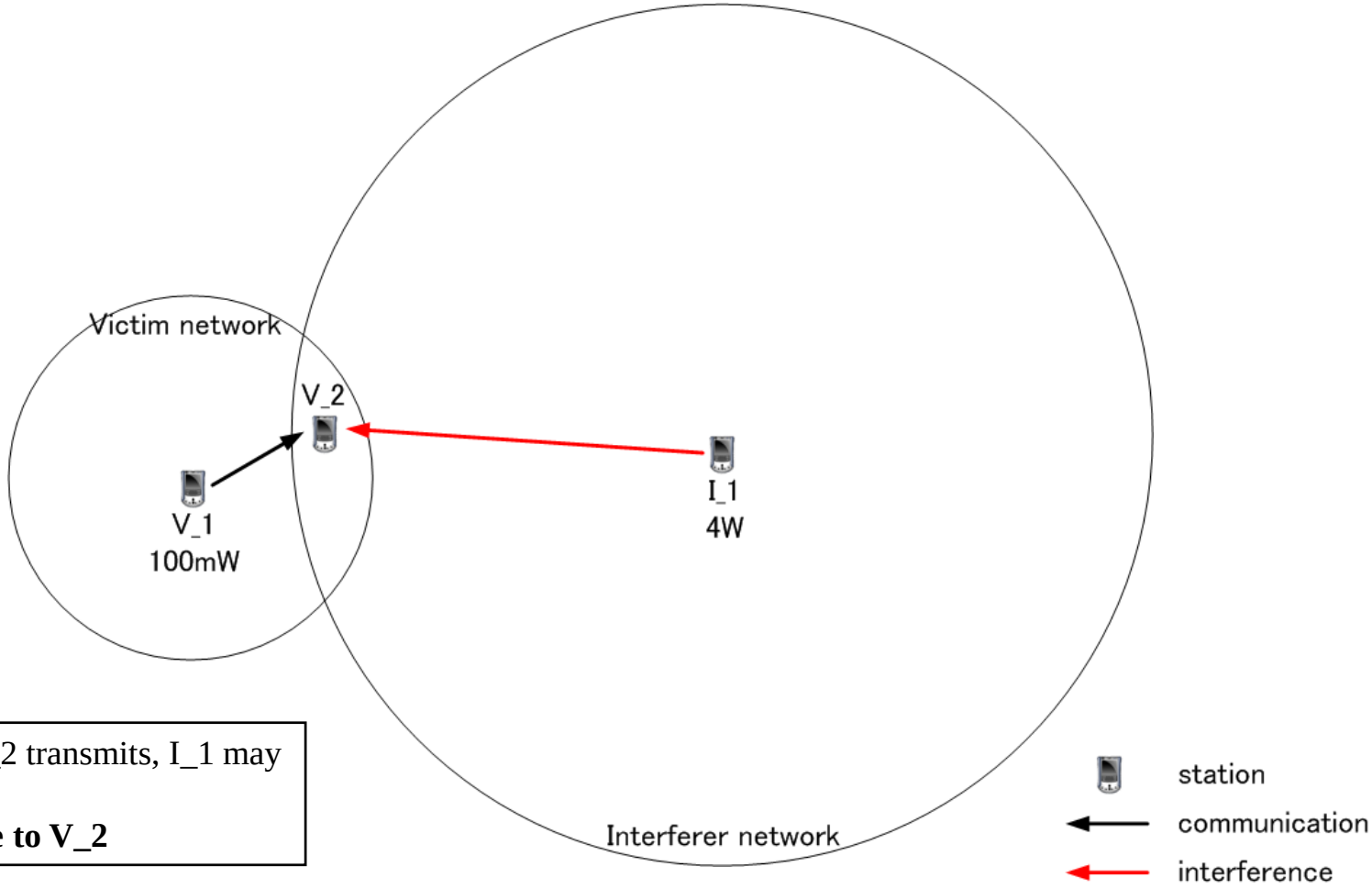


Mutated Hidden Node Problem ~Scenario 1~



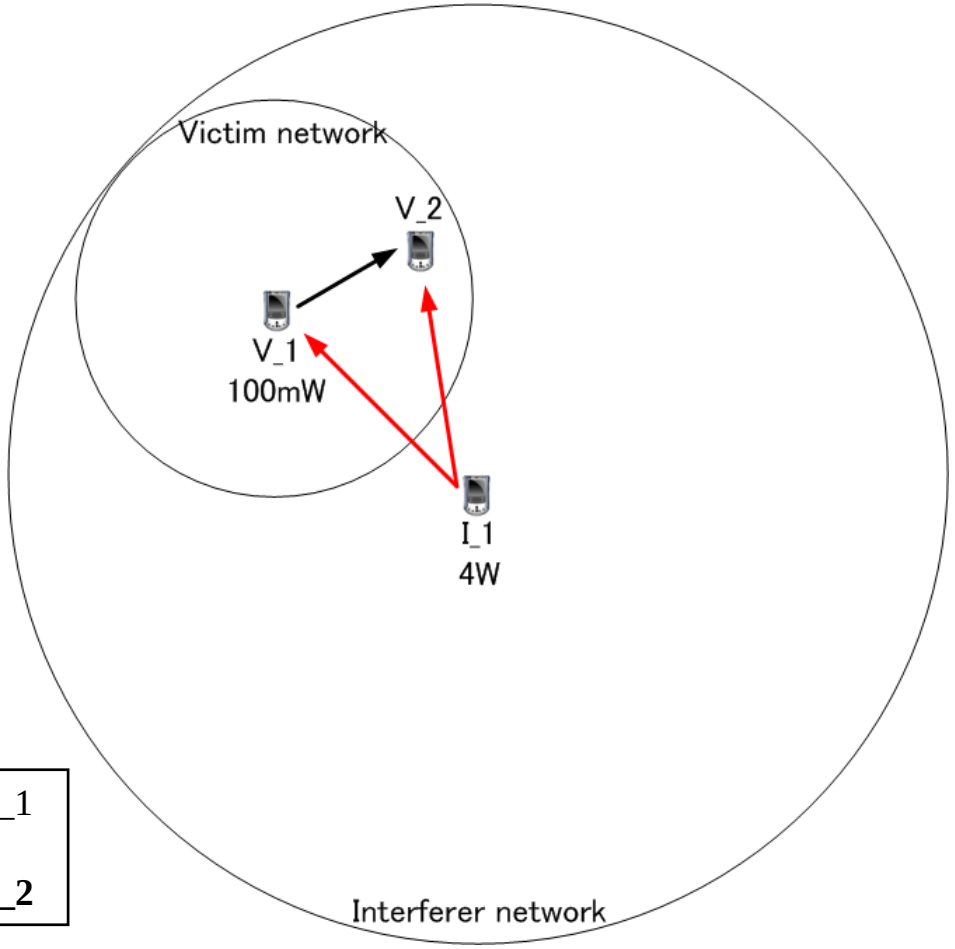
V_1, V_2 and I_1 are able to detect each other
No interference and no hidden node

Mutated Hidden Node Problem ~Scenario 2~



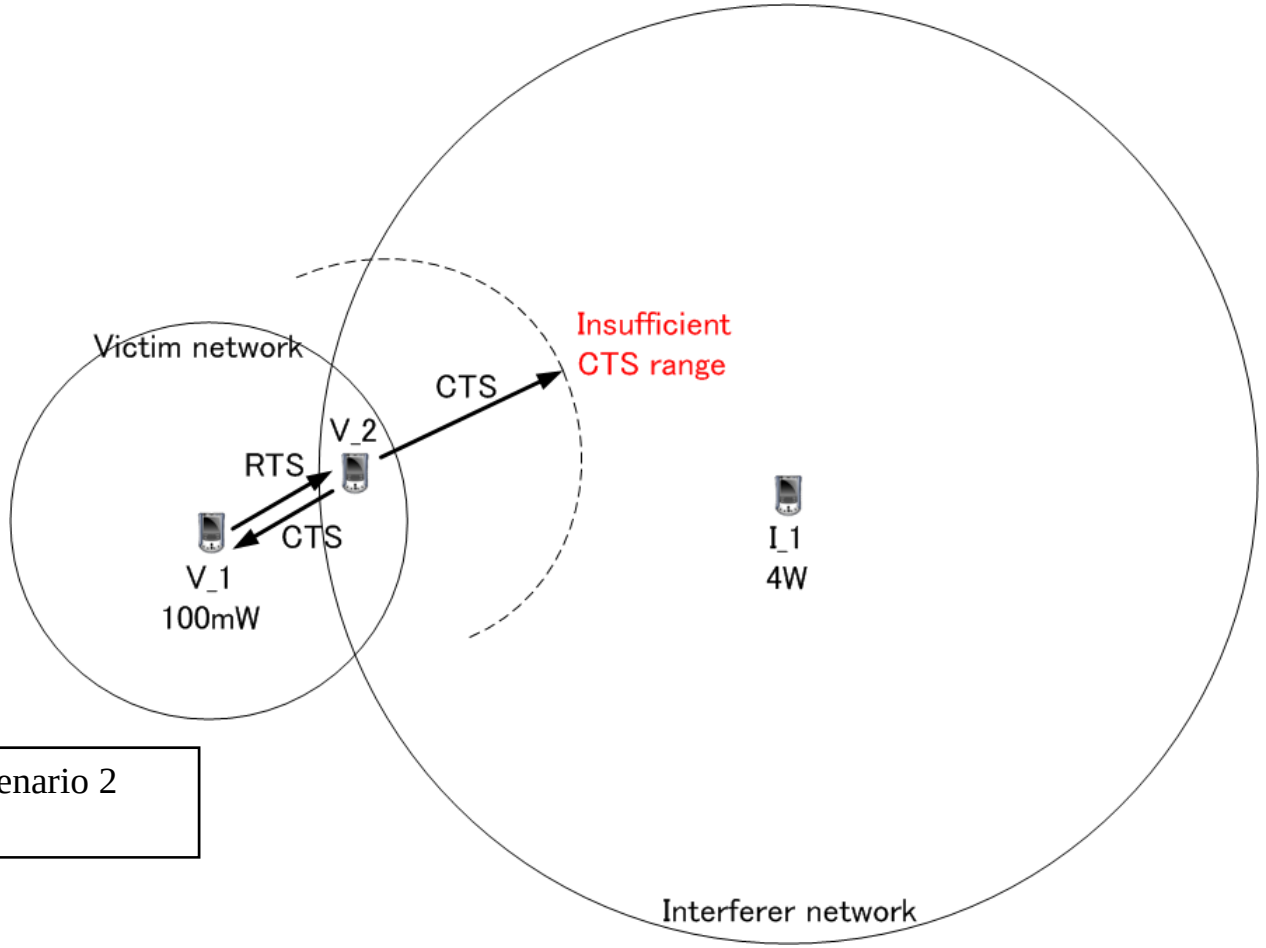
If V_1 or V_2 transmits, I_1 may also transmit
Interference to V_2

Mutated Hidden Node Problem ~Scenario 3~



If V_1 or V_2 transmits, I_1 may also transmit
Interference to V_1 or V_2

Mutated Hidden Node Problem ~Shortage of Classical RTS-CTS~

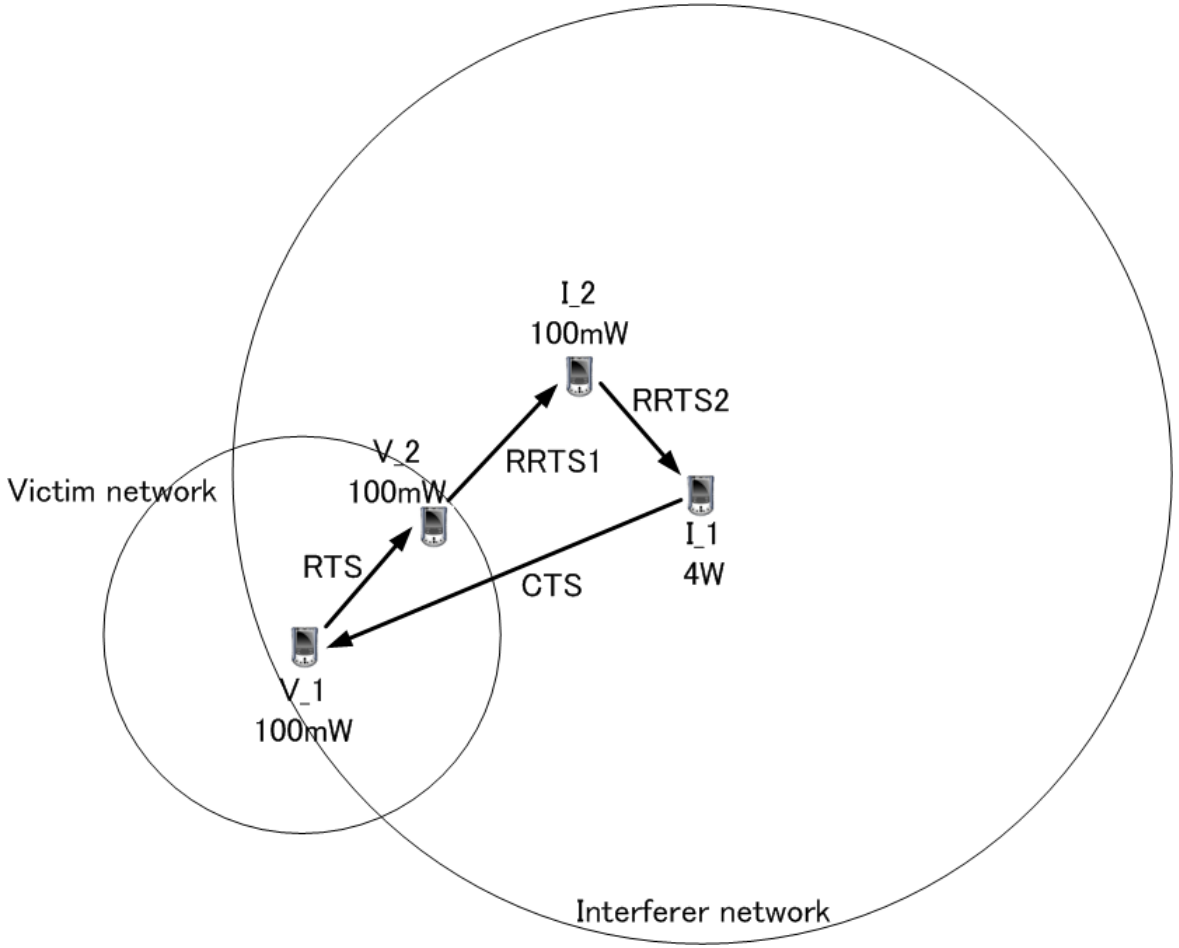


Probable for scenario 2 and scenario 3

Mutated Hidden Node Problem ~Discussion~

- Scenario 1 shows no hidden node problem
- Scenario 2 and 3 show that potential interference may be present due to hidden node
- Furthermore, the classical RTS-CTS solution may not be sufficient to tackle the problem
- The range of RTS has be extended to increase the efficiency of the RTS-CTS method

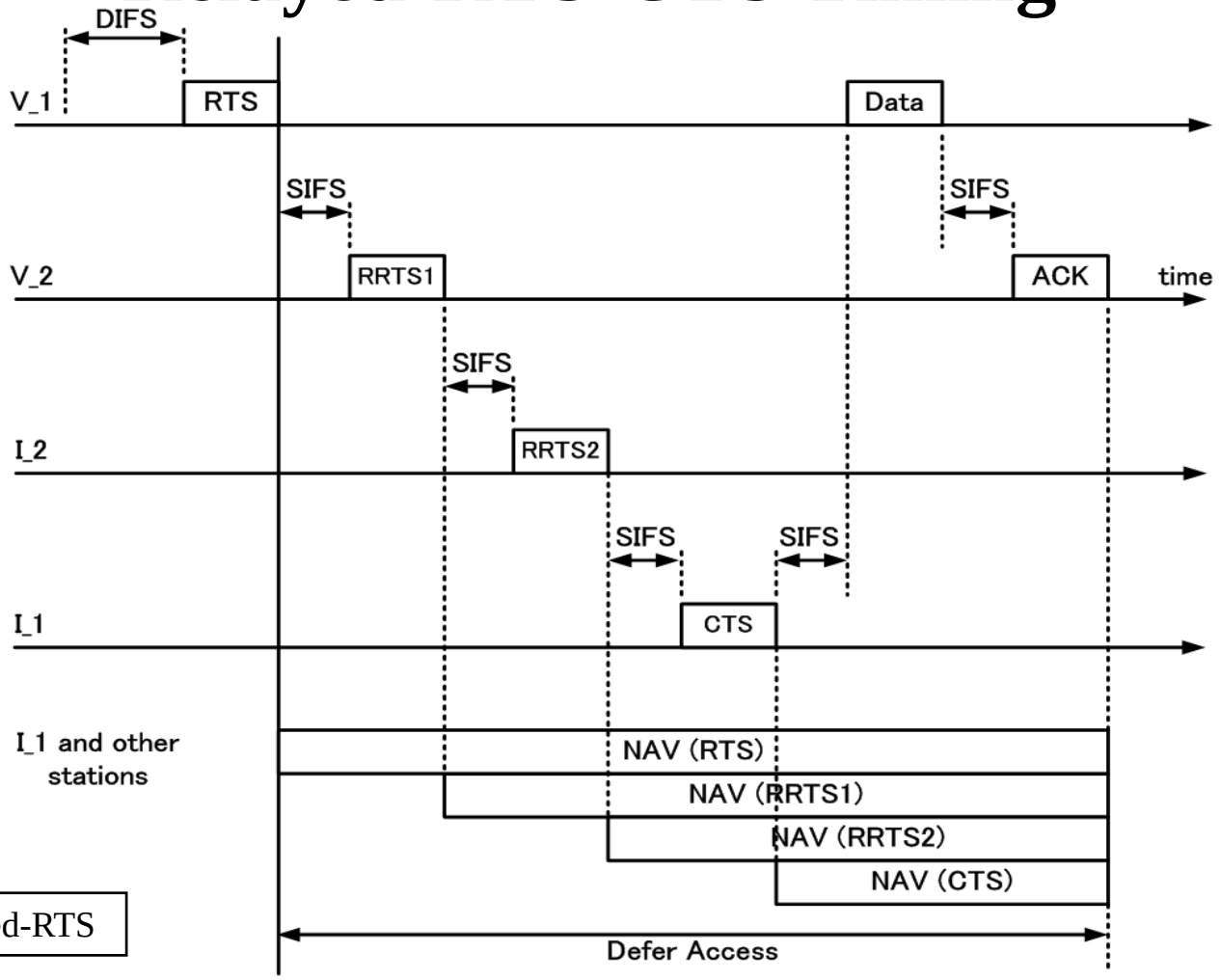
Mutated Hidden Node Solution ~Proposed Relayed-RTS-CTS Method~



Mutated Hidden Node Solution ~ Relayed-RTS-CTS Procedure~

- **Assumption:**
  - The initiating STA has the capability to obtain the addresses of the relaying STA(s)
- **Initiating STA send RTS to receiving STA**
- **In the receiving STA, by checking the Relay Control field and relay address fields:**
  - the receiving STA knows whether it should use the conventional RTS-CTS, or the relayed-RTS-CTS mechanism
  - the receiver knows whether it should act or ignore the incoming RRTS
- **The RRTS is continuously relayed until it reaches the destination STA**
- **The destination STA sends CTS to the initiating STA**
- **Initiating STA sends data upon receiving CTS**

Mutated Hidden Node Solution ~Relayed-RTS-CTS Timing~



RRTS – relayed-RTS

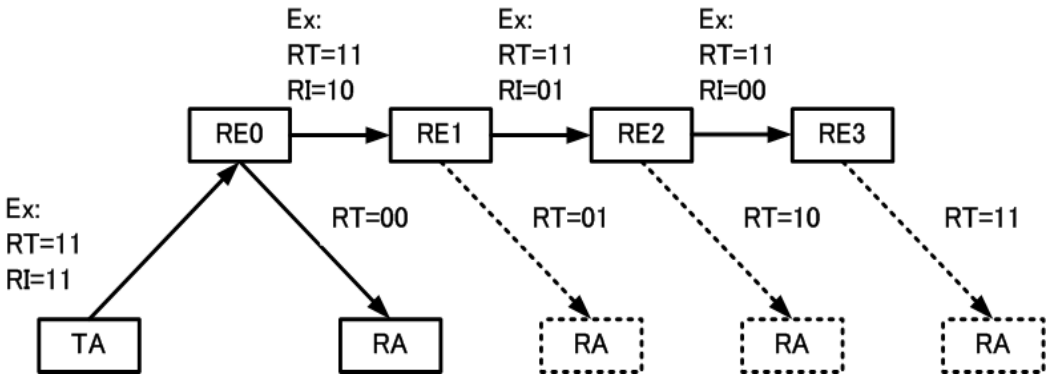
Required Changes to Legacy 802.11 (1/2) ~On the Existing RTS-CTS Procedure~

- The existing RTS-CTS mechanism remains the same
- On top of the RTS-CTS, an optional relayed-RTS-CTS mechanism is added
- Several procedural changes are needed in order to employ the relayed-RTS-CTS mechanism
- All procedural changes in the relayed-RTS mechanism do not affect the existing constant values and timing parameters
- The proposed solution may still be optimized for rare and extreme scenarios

Required Changes to Legacy 802.11 (2/2) ~Frame Format~

Octet: 2	2	6	6	1	6	6	6	6	4
Frame Control	Duration	RA	TA	Relay Control	RE0	RE1	RE2	RE3	FCS

- **Relay Control field**
  - Relay Type, RT (2 bits)
    - 00: Conventional RTS-CTS
    - 01: Relayed RTS-CTS with 1 relay
    - 10: Relayed RTS-CTS with 2 relays
    - 11: Relayed RTS-CTS with 3 relays
  - Relay Instance, RI (2 bits)
    - Gives the current relay STA
  - Reserve (4 bits)
- **RE1 to RE4 (6 octets each)**



Conclusion

- **This presentation explores the seriousness of the mutated hidden terminal in 802.11af**
- **This presentation proposes a solution to solve the mutated hidden node problem**
- **The solution requires minimum change in the legacy 802.11**