

CE474: Traffic Systems Design-Fall 2004

Class 23 – Traffic Signal System and ITS Architecture
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Zhen Li

National Institute for Advanced Transportation
Technology (NIATT), University of Idaho

Ahmed Abdel-Rahim

Civil Engineering Department, University of Idaho

Lab Report

- Introduction
- Problem Statement
- Methodology
- Experiment Result
- Conclusion

Barriers

- Barriers within the ring structure that are designed to reduce conflicts at the interchange may limit the order of the phases and the phases within an interval.
- The barriers included in the ring structures are placed for safety reasons at individual intersections.

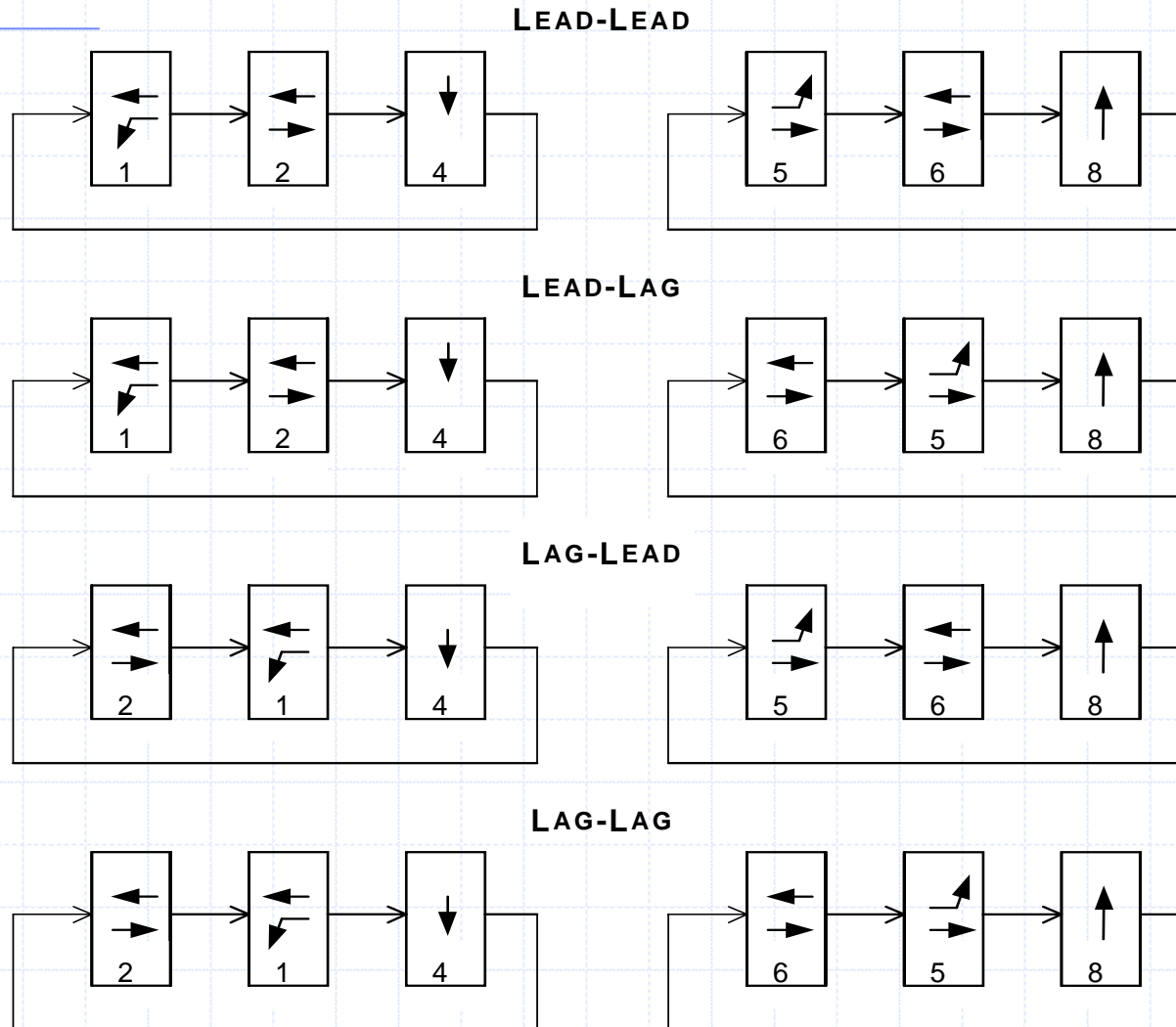
Fixed-time Three-phase Control

- Traditional three-phase control treats the diamond interchange as two intersections
- Each intersection having three basic movements (three phases) to service.
- There are four different phase orders
 - Lead-Lead
 - Lead-Lag
 - Lag-Lead
 - Lag-Lag

Fixed-time Three-phase Control

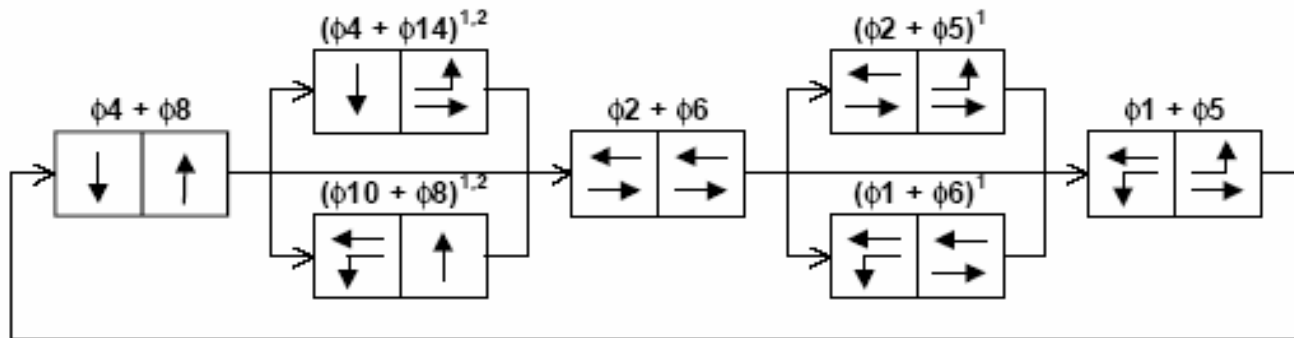
- The three phases at one of the intersections can be arranged in two different ways. Interior left turns can either lead or lag the arterial street movements.
- The decision to lead or lag the left-turn movements depends largely on the intensity of the turning movements at the interchange and which approach is more critical.

Three-phase Flexible Control



Three-phase pre-timed diamond interchange phasing.

Phase Sequence



Controller Ring Structure

ϕ_4	ϕ_{10}^2	ϕ_2	ϕ_1
ϕ_8	ϕ_{14}^2	ϕ_6	ϕ_5

Note:

¹ Optional overlap interval

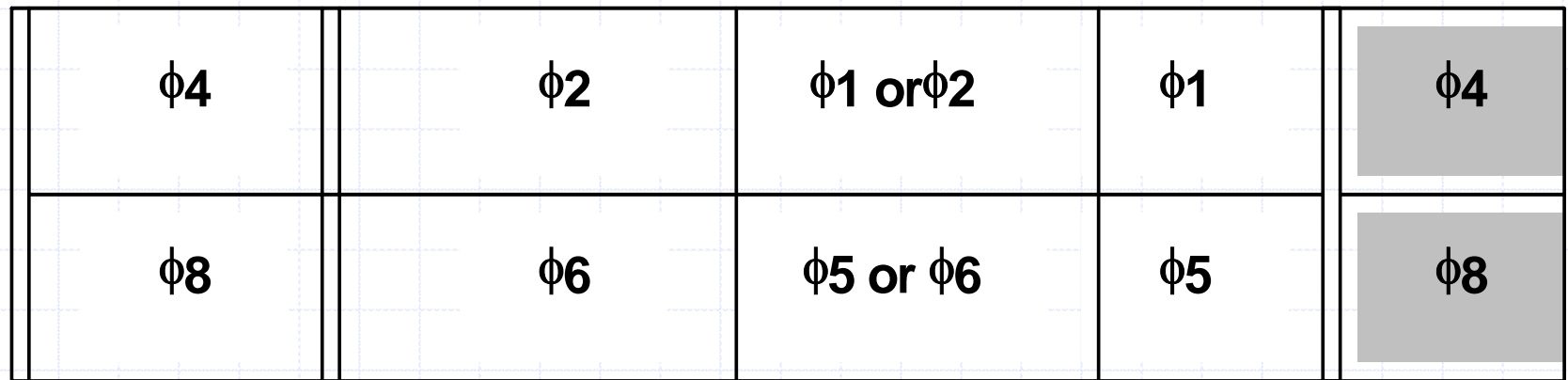
² 16-phase controller required

Three-phase Control

- The structures of three-phase actuated strategies are created through the use of barriers.
- There are three levels of flexibility that can be implemented:
 - basic
 - extended
 - flexible three-phase strategies (lead-lead, lead-lag, lag-lead, and lag-lag)

Three-phase Control

- Basic three-phase control requires the frontage road phases to begin and end together



←
←
BARRIERS

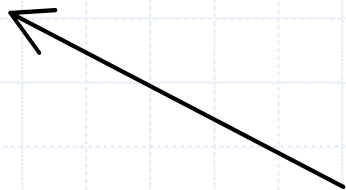
Three-phase Control

- The arterial and the interior movement can operate concurrent with one another.
- Interlocked movements will not be active at the same time.
- Using lag-lag phasing guarantees that the arterial will receive progression through the interchange because the left turn movement following the arterial phase widens the bandwidth for the arterial

Three-phase Control

- The extended three-phase solution maintains the initial barrier between the frontage roads and remove a barrier at the end of the frontage road movement.

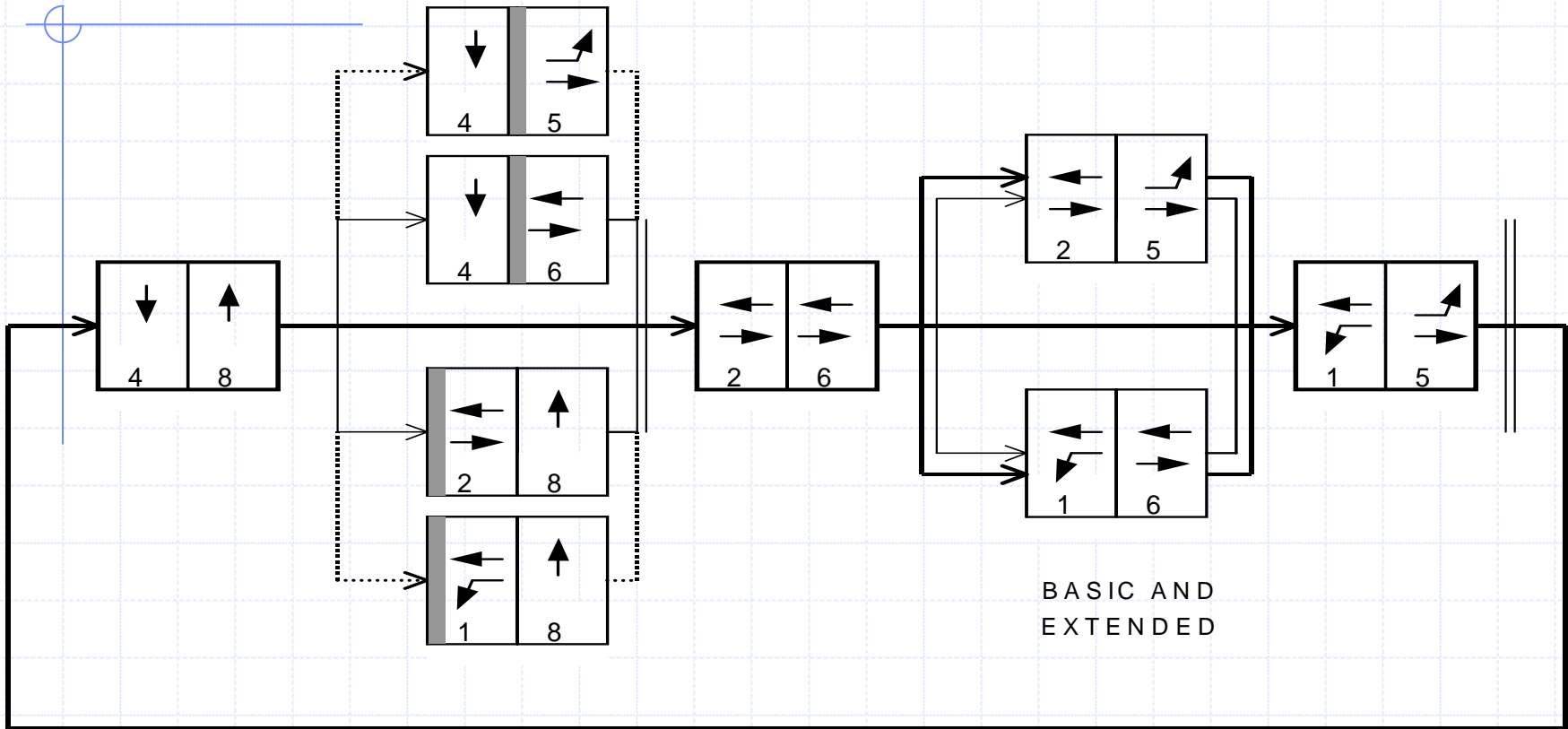
$\phi 4$	$\phi 4$ or $\phi 2$	$\phi 2$	$\phi 2$ or $\phi 1$	$\phi 1$	$\phi 4$
$\phi 8$	$\phi 6$ or $\phi 8$	$\phi 6$	$\phi 5$ or $\phi 6$	$\phi 5$	$\phi 8$



Three-phase Control

- The lack of a barrier at the end of the frontage road movement allows for early release of one of the frontage road phases, thereby allowing an opportunity for incompatible movement conflicts.
- Under actuated settings, allows the use of varying intervals and in some cases, multiple combinations of phases to serve traffic.

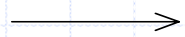
Three-phase Control



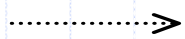
BASIC AND
EXTENDED



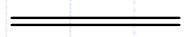
Primary Intervals (basic three-phase operation)



Phase Extension (extended three-phase operation)



Optional Overlap (typical of conditional service)



Barrier



Partial Barrier Crossing (for movement redefined within barrier)

Three-phase Control

- The advantages of three-phase control include the following:
 - the through traffic on the major arterial street approach is given preferential treatment.
 - utilize short cycle lengths, which improves responsiveness of the entire interchange.
 - better suited for interchanges with widely spaced intersections or light left turn volumes

Three-phase Control

Three-phase Disadvantages:

- a serious interior left turn storage problem is often created by this sequence.
- When there is a heavy left-turn movement from the cross street, as is often the case, the interior left-turn storage capacity may be exceeded, resulting in queue spillback from the left turn bays.

Three-phase Control

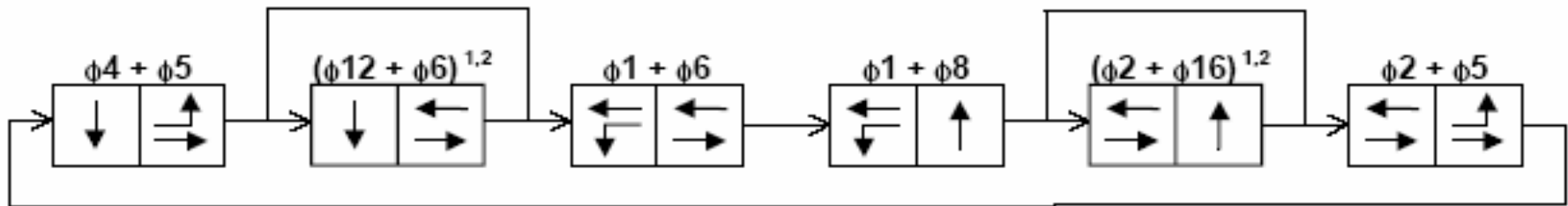
- Queue spillback will most probably block the through lanes and may possibly extend to the upstream intersection, with obvious adverse effects

Four-phase Control

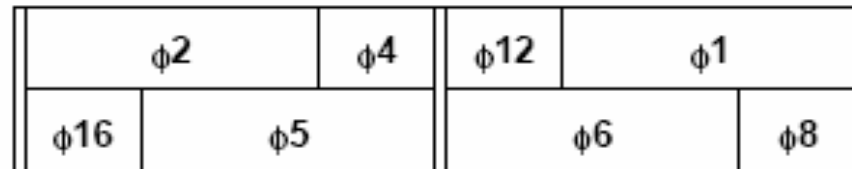
- In the late 1950's, the Texas Transportation Institute (TTI) developed the four-phase, two-overlap phasing sequence in following figure.
- The interchange is treated as a single intersection which has four basic intervals, (ϕ_4 and ϕ_5), (ϕ_1 and ϕ_6), (ϕ_1 and ϕ_8), and (ϕ_2 and ϕ_5)
- Protected left-turn phases for the interior movements (ϕ_1 and ϕ_5) are provided

Four-phase Control

Phase Sequence



Controller Ring Structure



Note:

¹ Optional overlap interval

² 16-phase controller required

Four-phase Control

- TTI four-phase control holds several advantages over Texas three-phase control.
 - The main advantage is that it minimizes queuing in the interior of the interchange.
This
 - It is especially helpful when cross street left turns are heavy, or storage space is small.

Four-phase Control

- It is recommended for isolated diamond interchanges, with one way ramps or frontage road intersections spaced less than 200 feet apart and potentially for interchanges up to 400 feet apart

Four-phase Control

- The main disadvantage of TTI four-phase control is reduced flexibility. Because
- the cycle is divided into four external intervals, the range in external phase times is limited, especially when compared to Texas three-phase operation.
- The overlap intervals, does add some efficiency to the operation of the interchange, but generally, TTI four-phase control is less efficient than Texas three-phase control.